Introductory Remarks

On March 29, 2005, pursuant to Patent Cooperation Treaty ("PCT") Rule 71.1 the International Preliminary Examination Authority of the United States Patent and Trademark Office ("IPEA/US") issued an International Preliminary Examination Report ("IPER") for PCT International Patent Application PCT/US2003/021927 ("the PCT patent application").

The PCT patent application corresponds to this United States patent application. The PCT patent application was filed with the PCT Receiving Office of the United States Patent and Trademark Office ("RO/US") on the same date as this patent application. Claims 1-19 in the PCT patent application are word-for-word identical to claims 1-19 now pending in this patent application.

The rejection which appears in the March 8, 2004, Office Action applies to the claims pending in this patent application the same reference, i.e. Shirasaki, et al. (US 2002/0044364 A1), as the reference applied to the claims of the PCT patent application in a Preliminary Written Opinion in IPEA issued by the IPEA/US on August 5, 2004. The March 29, 2005, IPER issued by the IPEA/US found that all the claims pending in the PCT patent application possessed both novelty and inventive step over Shirasaki, et al. (US 2002/0044364 A1).

On April 4, 2005, Applicants dispatched to the United States Patent and Trademark Office ("USPTO") for inclusion in this patent application a copy of the IPER issued by the IPEA/US on March 29, 2005. Accordingly, the IPER issued by the IPEA/US on March 29, 2005, is hereby incorporated by reference as though fully set forth here.

AMENDMENTS

There are no **Amendments to the Specification**.

There are no **Amendments to the Claims**.

Amendments to the Drawings begin on page 5 of this Response and include both an accompanying replacement sheet and an annotated sheet showing changes.

Remarks/Arguments begin on page 6 of this Response.

An **Appendix** including the amended drawing accompanies this Response.

Amendments to the Drawings

The accompanying drawing sheet, which replaces drawing sheet 7/8 of this patent application as originally filed, eliminates a handwritten annotation which appears on the original sheet 7/8.

Attachment: Replacement Sheet

Annotated Sheet Showing Changes

REMARKS

In view of the following remarks, the Applicants respectfully request reconsideration of the present application.

Objections and Rejections

The Office Action dated March 8, 2005:

1. rejects claims 1-9, 12-15, 17 and 19 under 35 U.S.C. § 102(e) as being anticipated by a Shirasaki, et al. published patent application US 2002/0044364 Al entitled "Optical Apparatus Which Uses a **Virtually Imaged Phased Array** to Produce Chromatic Dispersion" that was filed October 30, 2001, in the names of Masataka Shirasaki and Simon Cao ("the Shirasaki, et al. published application") as a:
    a. continuation-in-part ("CIP") of U.S. application Ser. No. 09/461,277, filed Dec. 14, 1999, and that issued October 2, 2001, as United States Patent no. 6,296,361 which the Shirasaki, et al. published application incorporates by reference; and
    b. that is related to and incorporates by reference:
        i. U.S. application Ser. No. 08/796,842, filed February 7, 1997, that issued July 27, 1999 as United States Patent no. 5,930,045;

ii. U.S. application Ser. No. 08/685,362, filed July 24, 1996, that issued December 7, 1991, as United States Patent no. 5,999,320; and

iii. U.S. application Ser. No. 08/910,251, filed Aug. 13, 1997 that issued October 19, 1999, as United States Patent no. 5,969,865, which in turn:

(1) was filed as a CIP both of:

(a) U.S. application Ser. No. 08/796,842, filed February 7, 1997, that issued July 27, 1999 as United States Patent no. 5,930,045; and

(b) U.S. application Ser. No. 08,685,362, filed July 26, 1996, that issued December 7, 1991, as United States Patent no. 5,999,320; and

(2) claims priority from Japanese patent application number 07-190535, filed in Japan on July 26, 1995;

2. rejects claims 10 and 11 under 35 U.S.C. § 103(a) as being unpatentably obvious in view of the Shirasaki, et al. published application; and

3. objects to claims 16 and 18 for depending from a rejected base claim, and states that claims 16 and 18 would be allowable if rewritten in independent form.

The Claimed Invention

The invention, as presently encompassed by independent apparatus claim 1, is an optical chromatic dispersion compensator adapted for bettering performance of an optical communication system.

The optical chromatic dispersion compensator includes a collimating means for receiving a spatially diverging beam of light which contains a plurality of frequencies. **The collimating means converts the received spatially diverging beam of light into a mainly collimated beam of light that is emitted from the collimating means**.

The optical chromatic dispersion compensator also includes **an optical phaser which provides an entrance window for receiving the mainly collimated beam of light from the collimating means**. **The optical phaser angularly disperses the received beam of light in a banded pattern that is emitted from the optical phaser**. In this way, the beam of light received by the optical phaser becomes separated into bands so that light having a particular frequency

within a specific band is angularly displaced from light at other frequencies within that same band.

Lastly, the optical chromatic dispersion compensator also includes a light-returning means which receives the angularly dispersed light having the banded pattern that is emitted from the optical phaser, and reflects that light back through the optical phaser to exit the optical phaser near its entrance window.

The Cited References

The Shirasaki, et al. Published Application

Exhibit A attached hereto reproduces FIGs. 7-11 and 13 of the Shirasaki, et al. published application. With respect to various of those FIGS., the Shirasaki, et al. published application, in pertinent part describes a virtually imaged phased array ("VIPA") as follows.

> [0103] Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76. Line 78 is hereinafter referred to as "focal line 78"**. **Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light**, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes

82a and 82b which are spatially distinguishable from each other.

[0105] **Input light 77 is focused into focal line 78 by lens 80 through radiation window 126**, to undergo multiple reflection between reflecting films 122 and 124. **Focal line 78 is preferably on the surface of plate 120 to which reflecting film 122 is applied**. Thus, **focal line 78 is essentially line focused onto reflecting film 122 through radiation window 126**. The width of focal line 78 can be referred to as the "beam waist" of input light 77 as focused by lens 80. Thus, the embodiment of the present invention as illustrated is FIG. 8 focuses the beam waist of input light 77 onto the far surface (that is, the surface having reflecting film 122 thereon) of plate 120. By focusing the beam waist on the far surface of plate 120, the present embodiment of the present invention reduces the possibility of overlap between (i) the area of radiation window 126 on the surface of plate 120 covered by input light 77 as it travels through radiation window 126 (for example, the area "a" illustrated in FIG. 11, discussed in more detail further below), and (ii) the area on reflecting film 124 covered by input light 77 when input light 77 is reflected for the first time by reflecting film 124 (for example, the area "b" illustrated in FIG. 11, discussed in more detail further below). It is desirable to reduce such overlap to ensure proper operation of the VIPA.

[0142] As illustrated in FIG. 13, **a light is output from a fiber 246, collimated by a collimating lens 248 and line-focused into VIPA 240 through radiation window 247 by a cylindrical lens 250**. **VIPA 240 then produces a collimated light 251** which is focused by a focusing lens 252 onto a mirror 254. Mirror 254 can be a mirror portion 256 formed on a substrate 258.

[0143] Mirror 254 reflects the light back through focusing lens 252 into VIPA 240. The light then undergoes multiple reflections in VIPA 240 and is output from radiation window 247. The light output from radiation window 247 travels through cylindrical lens 250 and collimating lens 248 and is received by fiber 246.

[0144] Therefore, light is output from VIPA 240 and reflected by mirror 254 back into VIPA 240. The light reflected by mirror 254 travels through the path which is exactly opposite in direction to the path through which

> it originally traveled. As will be seen in more detail below, different wavelength components in the light are focused onto different positions on mirror 254, and are reflected back to VIPA 240. As a result, different wavelength components travel different distances, to thereby produce chromatic dispersion.

Legal Principles Applicable to Rejections Under 35 U.S.C. 102(e)

> [F]or anticipation under 35 U.S.C. § 102, the reference must teach **every aspect** of the claimed invention either explicitly or impliedly. Any feature not directly taught must be inherently present. Manual of Patent Examining Procedure ("MPEP") Eighth Edition Revision 2, May 2004, § 706.02, p. 700-21 (Emphasis supplied)

"Anticipation under 35 U.S.C. § 102 requires the disclosure in a single piece of prior art of each and every limitation of a claimed invention." Rockwell International Corporation v. The United States, 147 F.3d 1358, 1363, 47 USPQ2d 1027, 1031 (Fed. Cir. 1998) citing National Presto Indus. v. West Bend Co., 76 F.3d 1184, 1189, 37 USPQ2d 1685, 1687 (Fed. Cir. 1966).

Argument

The Pending Application Acknowledges VIPA Chromatic Dispersion Compensation References

Because as set forth both above and in Exhibit B hereto, using a VIPA either to create or to compensate chromatic dispersion has been known for almost ten (10) years, i.e. since the filing of Japanese patent application number 07-190535 in Japan on July 26,

1995, Applicants when filing the pending patent application were aware that VIPAs existed, and of their use.

To address the issue that VIPAs are prior art to the present invention, the text of the pending application beginning on page 4 in line 35 presents the following description both of:

1. VIPA chromatic dispersion compensation devices, and

2. technological problems which they exhibit.

> An analogous chromatic dispersion compensation technique replaces the diffraction grating 50 with a virtually imaged phased array ("VIPA") such as that described in United States Patent no. 6,390,633 entitled "Optical Apparatus Which Uses a Virtually Imaged Phased Array to Produce Chromatic Dispersion" which issued May 21, 2002, on an application filed by Masataka Shirasaki and Simon Cao ("the '633 patent"). As illustrated in FIG. 3B, which reproduces FIG. 7 of the '633 patent, **the VIPA includes a line-focusing element, such as a cylindrical lens 57**, and a specially coated parallel plate 58. **A collimated beam 51 enters the VIPA through the line-focusing cylindrical lens 57** at a small angle of incidence, and emerges from the VIPA with large angular dispersion. In combination with the light-returning device 52 illustrated in FIG. 3A, the VIPA can generate sufficient chromatic dispersion to compensate for dispersion occurring in an optical fiber transmission system. Unfortunately, **the VIPA distributes the energy of the collimated beam 51 into multiple diffraction orders**. Because of each diffraction order exhibits different dispersion characteristics, **only one of the orders can be used in compensating for chromatic dispersion. Consequently, the VIPA exhibits high optical loss**, and **implementing dispersion slope compensation using a VIPA is both cumbersome and expensive**. **The VIPA also introduces high dispersion ripple**, i.e., rapid variation of residue dispersion with respect to wavelength, **which renders the VIPA unsuitable for inline chromatic dispersion compensation**.

The Present Invention Differs From VIPA Chromatic Dispersion Compensation References

Technologically distinguishing the present invention from VIPA chromatic dispersion compensation devices, the structure disclosed in the present application in all embodiments omits the semi-cylindrical lens 80 and cylindrical lens 250 which appear respectively in FIGs. 7 and 13 of the Shirasaki, et al. published application for focusing a collimated beam of light into a focal line or line-focusing which impinges upon a radiation window of the VIPA.

The text of the pending application beginning on page 14 in line 35 describes performance differences which exist between the present invention and VIPA chromatic dispersion compensation devices.

> **Although both the optical phaser 62 and VIPA have similar angular dispersion capabilities, their diffraction patterns differ significantly**. As illustrated schematically in FIG. 6A, **the beam waist inside the parallel plate 58 of the VIPA must be very small to simultaneously reduce both the angle φ and loss of optical energy**. Consequently, for a given wavelength of light λ **the narrow beam waist within the parallel plate 58 of the VIPA produces a large angular divergence of refracted beams**. In other words, **the energy of light diffracted by the VIPA is distributed into multiple orders**. Due to the different diffraction properties of the beams of different order, as stated previously **for the VIPA only one of the diffraction orders may be used for dispersion compensation**. Consequently, **the VIPA is an inherently high-loss device**. Alternatively, **the beam width inside the optical phaser 62 is similar to the thickness h of the optical phaser 62. This wide beam width within the optical phaser 62 causes optical energy**

of light refracted at the surface 65 to be mainly concentrated in a single order for any beam of light at a particular wavelength as illustrated schematically in FIG. 6B.

Texts of Pending Claims Distinguish VIPA Chromatic Dispersion Compensation References

The text of pending independent apparatus claim 1 requires that:

1. a spatially diverging beam of light such as that emitted from an optical fiber be converted into a mainly collimated beam of light; and
2. the mainly collimated beam of light be received into an optical phaser which disperses the received light into a banded pattern emitted from the optical phaser.

The March 8, 2005, Office Action in explaining that claims 1-9, 12-15, 17, 19 are anticipated under 35 U.S.C. § 102(e) by the Shirasaki, et al. published application, citing only paragraph [0021] thereof, in pertinent part alleges:

1. the **collimating means also converting the received spatially diverging beams of light into a mainly collimated beam of light that is emitted from the collimating means** (Fig. 13);
2. an optical phaser which provides **an entrance window for receiving the mainly collimated beam of light from the collimating means** and **for angularly dispersing the received beam of light in a banded pattern** that is emitted from the optical phase (paragraph 0021); and
3. whereby **the received beam of light becomes separated into bands so that light having a particular frequency (or wavelength) within a specific band is angularly displaced**

> **from light at other frequencies within that same band** (paragraph 0021).

Applicants respectfully submit that **the preceding excerpt** from the March 8, 2005, Office Action, while identifying FIG. 13, **completely overlooks and is expressly contradicted by disclosures appearing elsewhere in texts of the Shirasaki, et al. published application** in addition to paragraph [0021] that are excerpted above such as:

1. **paragraphs [0142]-[0144] which describe FIG. 13**; and also
2. paragraphs [0103] and [0105].

Specifically with respect to FIG. 13 which appears in Exhibit A hereto, the Shirasaki, et al. published application declares in paragraph [0144] that:

1. a light is output from a fiber 246;
2. is collimated by a collimating lens 248; and
3. **line-focused by a cylindrical lens 250**;
4. **into VIPA 240 through radiation window 247**.

Thus, **the text of the Shirasaki, et al. published application in paragraph [0144] expressly contradicts the allegation in the March 8, 2005, Office Action that**:

> the **collimating means also converting the received spatially diverging beams of light into a mainly collimated beam of light that is emitted from the collimating means** (Fig. 13); an optical phaser which provides **an entrance window for receiving the mainly collimated beam of light from the collimating means**.

Similarly with respect to FIG. 13, the Shirasaki, et al. published application declares in paragraph [0144] that:

1. **line-focused light entering the VIPA 240 through radiation window 247**;
2. **exits the VIPA 240 as a collimated light 251**.

Consequently, **the text of the Shirasaki, et al. published application again in paragraph [0144] expressly contradicts the allegation in the March 8, 2005, Office Action that** the reference discloses:

> an optical phaser . . . **for angularly dispersing the received beam of light in a banded pattern** that is emitted from the optical phase (paragraph 0021); whereby **the received beam of light becomes separated into bands so that light having a particular frequency (or wavelength) within a specific band is angularly displaced from light at other frequencies within that same band**.

Furthermore, not only does the text of paragraph [0144] expressly contradict the March 8, 2005, Office Action's allegations that the Shirasaki, et al. published patent application discloses a collimated beam of light impinging upon an entrance window an optical phaser which angularly disperses the received beam of light in a banded pattern that is emitted from the optical phaser, **paragraphs [0103] and [0105] excerpted above also contradict the March 8, 2005, Office Action's allegation**.

Not only do paragraphs [0103], [0105] and [0142]-[0144] expressly contradict the March 8, 2005, Office Action's allegations, no fewer that **twenty (20) issued United States patents** which contain the phrase "Virtually Imaged Phased Array" in their title and which are listed in Exhibit D hereto, every one of which identifies Masataka Shirasaki as an inventor and is assigned to

Fujitsu Limited, as excerpted in Exhibit R hereto **expressly disclose that light impinging upon a VIPA's radiation window is focused into a line** thereby expressly contradicting the March 8, 2005, Office Action's allegation. Moreover, yet another **nine (9) issued United States patents** assigned to only Avanex Corporation, a non-exclusive licensee of Fujitsu Limited's VIPA technology[1], which contain the phrase "Virtually Imaged Phased Array" in their title and which are listed in Exhibit F hereto also, as excerpted in Exhibit S hereto, **expressly disclose that light impinging upon a VIPA's radiation window is focused into a line** thereby expressly contradicting the March 8, 2005, Office Action's allegation. Finally, an abstract and FIG. 3 for **Japanese patent application number 07-190535** which appear in Exhibit C hereto, i.e. the origin for the twenty-nine (29) issued United States patents which contain the phrase "Virtually Imaged Phased Array" in their title and which are listed in Exhibits D and F hereto, **expressly discloses that light impinging upon a VIPA's radiation window is focused into a line** thereby expressly contradicting the March 8, 2005, Office Action's allegation.

For the preceding reasons as established by Exhibits C, R and S hereto, indisputably **input light impinging upon a VIPA's radiation window**, such as that disclosed in the Shirasaki, et al.

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1 See Exhibits E and G hereto.

published application, **is always focused into a line**. Conversely, **pending independent claim 1 requires that a "mainly collimated beam of light" impinge upon the optical phaser** disclosed in the present application. Since the Shirasaki, et al. published application and all other related issued VIPA United States patents listed in Exhibits D and F and Japanese patent application number 07-190535 as summarized in Exhibit C hereto all fail to disclose that a "mainly collimated beam of light" impinges upon a VIPA's radiation window, **Applicants respectfully submit that**, contrary to the allegation in the March 8, 2005, Office Action:

1. **the Shirasaki, et al. published application cannot anticipate claims 1-9, 12-15, 17 and 19**; and
2. **claims 1-9, 12-15, 17 and 19 are novel with respect to that reference**.

Furthermore, because the Shirasaki, et al. published application and all other related VIPA issued patents listed in Exhibits D and F hereto expressly disclose that **input light impinging upon a VIPA's radiation window is always focused into a line**, **the Shirasaki, et al. published application**, as well as all other related VIPA issued patents listed in Exhibits D and F hereto, **teaches away from** the requirement expressed in **pending independent claim 1 that a "mainly collimated beam of light" impinge upon the optical phaser** disclosed in the present application. Because **the**

Shirasaki, et al. published application teaches away from the requirement expressed in **pending independent claim 1** that a "mainly collimated beam of light" impinge upon the optical phaser disclosed in the present application, **that reference**:

1. **cannot render claims 10 and 11 obvious**; and
2. therefore, **claims 1-19 are not obvious under 35 U.S.C. § 103(a) in view of that reference**.

Not only as explained above does there exist a difference between light impinging upon a VIPA's radiation window and an optical phaser's entrance window, there also exists a difference between light emitted from a VIPA and from an optical phaser. The texts of **independent claim 1 requires that the mainly collimated beam of light received into an optical phaser be dispersed by the optical phaser into a banded pattern emitted from the optical phaser**. The Shirasaki, et al. published application expressly declares in paragraph [0144] that:

1. **line-focused light entering the VIPA 240 through radiation window 247**;
2. **exits the VIPA 240 as a collimated light 251**.

Because of the preceding difference between light emitted from a VIPA and from an optical phaser as recited in independent claim 1, **Applicants respectfully submit that**, contrary to the allegation in the March 8, 2005, Office Action, for a second independent reason:

1. **the Shirasaki, et al. published application does not anticipate claims 1-9, 12-15, 17 and 19**; and
2. **claims 1-9, 12-15, 17 and 19 are novel with respect to that reference**.

Furthermore, because the Shirasaki, et al. published application expressly discloses that **light emitted from a VIPA is collimated**, **the Shirasaki, et al. published application teaches away from** the requirement expressed in **pending independent claim 1** that **the optical phaser emit a banded pattern of light**. Because **the Shirasaki, et al. published application teaches away from** the requirement expressed in **pending independent claim 1** that the optical phaser emit a banded pattern of light, **that reference**:

1. **cannot render claims 10 and 11 obvious**; and
2. therefore, **claims 1-19 are not obvious under 35 U.S.C. § 103(a) in view of that reference**.

VIPA Chromatic Dispersion Compensation Devices Have Failed Commercially

As established by Exhibits B-Q hereto, at least as early as July 26, 1995, i.e. almost ten (10) years ago, Fujitsu Limited filed Japanese patent application JP 07-190535 naming Masataka Shirasaki as the inventor of an invention which uses a VIPA. Since then, no fewer than twenty (20) United States patents, listed in Exhibit D hereto, have issued which:

1. include the phrase "Virtually Imaged Phased Array," in their title;
2. identify Masataka Shirasaki as an inventor; and
3. are assigned to Fujitsu Limited.

Slightly more than four (4) years after filing Japanese patent application JP 07-190535, Fujitsu Limited on September 13, 1999, granted Avanex Corporation of Fremont, California a non-exclusive license to commercially exploit Fujitsu Limited's VIPA technology. Subsequently, no fewer than nine (9) United States patents, listed in Exhibit F hereto, have issued which:

1. include the phrase "Virtually Imaged Phased Array," in their title; and
2. are assigned to only Avanex Corporation.

Approximately twenty-two (22) months after Avanex Corporation procured a license for VIPA technology from Fujitsu Limited, on July 16, 2001, Avanex Corporation issued a press release describing **a common specification with Fujitsu Limited for VIPA-type dispersion compensation modules for optical transmission systems**.

Approximately fourteen (14) months later, on September 17, 2002, **Avanex Corporation** issued another press release:

1. **announcing its PowerShaper(TM) dispersion compensation products**; and

2. describing them as **employing Avanex Corporation's proprietary and patented Gires-Tournois (GT) etalon technology**.

Approximately five (5) months ago and twenty (20) months after announcing PowerShaper(TM) dispersion compensation products, on May 11, 2004, Avanex Corporation issued yet another press release announcing shipment to more than 20 customers for trials and deployments its dispersion compensation solution, which use its proprietary and patented Gires-Tournois (GT) etalon technology.

Fujitsu's most recent brochures for its Flashwave® 4500-V6 and 7500 products describes providing dispersion compensation as part of Netstender 1020 and 2060 systems sold by BTI Photonic Systems, Inc. of Ottawa, Ontario, Canada.

Just one month ago, between September 5-9, 2004, a session on the subject of dispersion compensation was held at the "30th European Conference on Optical Communication."

It appears abundantly clear from the evidence provided by Exhibits B-Q hereto that, despite all the announcements and patenting, VIPA technology has failed to provide commercially practical dispersion compensation for fiber optic communication systems. What is less readily apparent is that while VIPA technology allegedly offered a possibility for tunable dispersion compensa-

tion,[2] Fujitsu Limited and Avanex Corporation today offer only fixed, not tunable, dispersion compensation products.

Therefore, presently dispersion compensation for fiber optic communication systems remains a technological problem which still needs a truly practical solution. The present invention, due to fundamental technological differences from VIPA technology embodied in the pending claims, provides a truly practical solution to the problem of dispersion compensation for fiber optic communication systems. Moreover, as contrasted with the dispersion compensation products presently being offered by Fujitsu and Avanex Corporation the present invention provides tunable, rather than fixed, dispersion compensation for fiber optic communication systems.[3]

Conclusion

Applicants respectfully submit that, for the reasons set forth above, pending claims 1-19 all distinguish VIPA dispersion compensation devices as described in the Shirasaki, et al. published application, as well as in the twenty-nine (29) issued United States patents listed in Exhibits D and F. Specifically, pending

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[2] See Exhibit J hereto which contains a copy of a Fujitsu Limited October 16, 2002, press release.

[3] See the present application on page 22 beginning at line 34.

claims 1-19 distinguish all of the VIPA references at least because independent claim 1 expressly requires that:

1. a mainly collimated beam of light impinge upon the optical phaser, as contrasted with a linear beam of light as required for a VIPA; and
2. the optical phaser disperses the mainly collimated beam of light impinging thereon into a banded pattern which is emitted from the optical phaser, as contrasted with the collimated light which exits a VIPA.

For the preceding reasons, Applicants respectfully request reconsideration of the March 8, 2004, Office Action, and issuance of a Notice of Allowability declaring that claims 1-19 are patentable over the Shirasaki, et al. published application.

Respectfully submitted

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Chronological, Historical Overview of Chromatic Dispersion Compensation Focused On Using Virtually Imaged Phased Array Devices

The Beginning

At least as early as July 26, 1995, i.e. almost ten (10) years ago, Fujitsu Limited filed Japanese patent application JP 07-190535 naming Masataka Shirasaki as the inventor for an invention which uses a virtually imaged phased array ("VIPA").[4]

FIG. 3 of Japanese patent application JP 07-190535 depicts a reflective multi-layered film 32 formed on a flat plate 33 having an irradiation window 33 upon which impinges incident light 38 formed into a focal line 36. The incident light 38 repeats multiple reflection while being spread in the parallel flat plate 30. At every reflection from the reflective multi-layered film 32, a part of the light is emitted outside to cause interference to form a flux 37.

Fujitsu VIPA Patenting

During the past ten (10) years, at least twenty (20) United States Patents have issued which:

1. relate to VIPA technology; and
2. are assigned to Fujitsu Limited.[5]

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[4] Exhibit C attached hereto reproduces a Patent Abstract of Japan for Japanese patent application JP 07-190535 filed July 26, 1995, from which Fujitsu Limited's United States Patent No. 5,930,045 claims priority, together with an annotated copy of FIG. 3 therefrom.

[5] See Exhibit D hereto which lists all United States patents:
1. having titles which includes all of the words "virtually," "imaged" and "array;" and
2. which identify "Fujitsu" as the patent's assignee.

Fujitsu Licensing

On September 13, 1999, Fujitsu Limited granted Avanex Corporation of Fremont, California a non-exclusive license for dispersion compensation under:

> all the patents issued under the following patent applications and their divisions, continuations and continuation-in-parts, and all reissues of any of the foregoing patents: [Certain information on this page has been omitted and filed separately with the Commission.][6]

Under the terms of the Fujitsu Limited - Avanex Corporation patent license agreement:

> "LICENSED PRODUCTS" shall mean the following items (1) and (2):
> (1) Wavelength multiplexer/demultiplexer devices which consist of the VIPA element.
> (2) Chromatic dispersion compensator devices which consist of the VIPA element and a mirror.

The publicly accessible portion of the Fujitsu Limited - Avanex Corporation patent license agreement lacks any definition for the term "VIPA element."

Avanex VIPA Patenting

Avanex Corporation is identified as a joint assignee on some of the twenty (20) issued United States Patents which:

1. relate to VIPA technology; and
2. are assigned to Fujitsu Limited.

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[6] See Exhibit E hereto which contains a publicly available copy of the Fujitsu Limited - Avanex Corporation patent license agreement, and correspondence pertinent thereto.

During the past three (3) years, at least nine (9) United States Patents have issued which:

1. relate to VIPA technology; and
2. are assigned to only Avanex Corporation.[7]

Fujitsu-Avanex Common Specification

On July 16, 2001, Avanex Corporation issued a press release entitled "Fujitsu and Avanex Reach Agreement on **Common Specification for VIPA-Type Dispersion Compensation Modules for Optical Transmission Systems**."[8] Pertinent portions of the Avanex Corporation July 16, 2001, press release state:

1. Fujitsu Limited and Avanex Corporation have reached an agreement to standardize specifications for Virtually Imaged Phased Array dispersion compensation modules, a **tunable type of dispersion compensation device** considered indispensable to realizing next- generation 40-gigabit-per-second high-speed optical transmission systems;
2. **VIPA comprises a thin plate coated on both sides with a reflecting film and a reflecting mirror**;
3. VIPA is a type of **tunable dispersion compensation module** that can flexibly support the fluctuating dispersion characteristics of high-speed transmission;
4. until now, conventional optical transmission systems that operate at 10 gigabits per second have corrected wavelength dispersion by using a dispersion compensating fiber (DCF);
5. next-generation high-speed optical transmission systems, however, require higher performance wavelength compensation devices, such as "tunable" types, capable of making minute corrections to wavelength dispersion, which

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[7] See Exhibit F hereto which lists all United States patents:
1. having titles which includes all of the words "virtually," "imaged" and "array;" and
2. which identify "Avanex" as the patent's assignee while omitting "Fujitsu" as an assignee of the patent.

[8] See Exhibit G hereto which contains a copy of the Avanex Corporation's press release.

changes according to environmental factors such as the type and length of fiber as well as temperature;

6. since 1998, Fujitsu and Avanex have been separately developing new tunable-type dispersion compensation modules that utilize VIPA technology;
7. **Fujitsu is currently sampling VIPA-type dispersion compensation modules for 10-gigabit-per-second optical transmission systems and plans to start volume shipments in late 2001**;
8. **Fujitsu is now developing VIPA-type dispersion compensation modules for next-generation 40-gigabit-per-second high-speed optical transmission systems, with product shipments expected to begin in 2002**;
9. **Avanex is currently marketing the VIPA dispersion compensator devices under the PowerShaper(TM) trademark**;
10. **the PowerShaper(TM) product for 10-gigabit-per-second OC-192 transmission application is in pilot production stage and has been deployed in the field since 2000**; and
11. **The PowerShaper(TM) products for 40-gigabit-per-second applications have already successfully passed a number of field trials, and plans are to go into pilot production in the second half of 2001**.

Avanex PowerShaper™
Dispersion Compensation Modules

Approximately fourteen (14) months later, on September 17, 2002, Avanex Corporation issued another press release entitled "Avanex Reports Numerous Commercial Shipments of PowerShaper(TM) FDS, its Suite of Low-Cost and Small-Form-Factor Dispersion Compensation Modules."[9] Pertinent portions of the September 17, 2002, Avanex Corporation press release state:

1. "The PowerShaper FDS's low cost, small form factor and 100% slope compensating solution provides a superior alternative to legacy dispersion compensation fiber products for both metro and long-haul applications;" and
2. **PowerShaper FDS employs Gires-Tournois (GT) etalons** and is based upon proprietary Avanex technology.

A technical paper by Scott Campbell, Ph.D. entitled "What is an Etalon and How is it Useful in Dispersion Compensation?" is at-

[9] See Exhibit H hereto which contains a copy of the Avanex Corporation's press release.

tached hereto as Exhibit I. The technical paper on its 3rd page describes a Gires-Tournois (GT) etalon as follows.

> A sub-class of the Fabry-Perot etalon is called a Gires-Tournois etalon, invented in the mid 1960's and named after its inventors. A Gires-Tournois etalon (GTE) has its first mirror partially reflective (like the FPEJ, but its second mirror is 100% reflective. In this manner, all of the light enters and exits the GTE through its first mirror whether it wants to or not.
>
> * * *
>
> It should be noted that even though all of the colors of light will exit the GTE through the same mirror they entered through, those colors that want to transmit but must now reflect will still have the longest time delay induced upon them by the etalon . . . . The intent of the GTE is thus to only induce a periodic time delay on the light (while 100% reflecting all of its colors).

Fujitsu Press Release

Approximately fifteen (15) months after Avanex Corporation issued the July 19, 2000, press release regarding the "Common Specification for VIPA-Type Dispersion Compensation Modules," on October 16, 2002, Fujitsu Limited issued a press release entitled "Fujitsu Achieves Terabit-WDM Transmission at 40 Gbps per Channel over Legacy Optical Fiber Cable."[10] Pertinent portions of the October 16, 2002, Fujitsu Limited press release state:

1. Fujitsu Limited has successfully transmitted a 1.76-terabit per second signal over 600 km of the most conventional type of optical fiber currently installed around the world;
2. the signal consisted of 44 separate single-wavelength signals, each with a data rate of 40 Gbps, multiplexed together;
3. Fujitsu has been developing a next-generation 40 Gbps per channel wavelength-division multiplexing (WDM) system:
    a. which could only run on the very latest optical fiber with optimized chromatic dispersion management and low polarization-mode dispersion; and

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[10] See Exhibit J hereto which contains a copy of the Fujitsu Limited's press release.

   b. the most commonly used fiber in the world, which is relatively old, would not support these systems;
4. **supporting a 40 Gbps WDM transmission system over legacy fiber requires**, among other things, **technology to compensate for** waveform degradation that results from **variations in chromatic dispersion** due to temperature changes in the installed cable (chromatic dispersion compensation);
5. **Fujitsu developed an automatic feedback-control function in the form of a virtually imaged phased array (VIPA) variable dispersion compensator that optimizes the compensation value while monitoring incoming signal characteristics**;
6. the VIPA variable-dispersion compensator consists of:
   a. a VIPA plate-a wavelength diffractive grating, consisting of reflective coatings on both sides of a thin glass plate; and
   b. a three-dimensional mirror; and
7. moving the three-dimensional mirror horizontally results in variable dispersion compensation with a range of -800 to +800 ps/nm over the entire C-band (1530-1560 nm) for a 40-Gbps NRZ signal.

Avanex PowerShaper™ Patent

Approximately twenty (20) months after Avanex Corporation issued the July 19, 2000, press release regarding the "Common Specification for VIPA-Type Dispersion Compensation Modules," on March 25, 2003, Avanex Corporation issued another press release entitled "Avanex Awarded U.S. Patent For Etalon-Based Dispersion Compensation Technology Employed in PowerShaper(TM) FDS Modules."[11] Pertinent portions of the March 25, 2003, Avanex Corporation press release state:

1. that **Avanex Corporation has been awarded U.S. Patent: 6,487,342 for the etalon-based dispersion compensation technology incorporated in its PowerShaper(TM) FDS dispersion compensation module**; and
2. **the PowerShaper(TM) FDS module compensates for chromatic dispersion using cascaded Gires-Tournois etalons**.

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[11] See Exhibit K hereto which contains a copy of the Avanex Corporation's press release.

Avanex Corporation's United States Patent No. 6,487,342 describes "Gires-Tournois" interferometers, etalons, as follows.

> FIG. 1b illustrates a first preferred embodiment of a Gires-Tournois interferometer that may be utilized within the chromatic dispersion compensator in accordance with the present invention. The Gires-Tournois interferometer 108.1 comprises two glass plates 180A-180B optically coupled to one another, wherein the first glass plate 180A comprises a wedge shape. The inside face of the second glass plate 180B is coated to form a reflective surface 120 with a reflectivity preferably of approximately 100%. The inside face of the first glass plate 180A is substantially parallel to the inside face of glass plate 180B and is coated to form a partially reflective surface 140 with a reflectivity less than 100%. The two glass plates are separated by spacers 112, such that an interferometric cavity 110 of optical path length L_o is created between the partially reflective surface 140 and the 100% reflective surface 120. The spacers 112 preferably comprise a zero-thermal-expansion or low-thermal-expansion material. The length of the spacers 112 is adjusted during manufacture so as to provide a desired periodicity to the chromatic dispersion of the Gires-Tournois interferometer 108.
>
> * * *
>
> FIG. 1c illustrates a second preferred embodiment of a Gires-Tournois interferometer that may be utilized within the chromatic dispersion compensator in accordance with the present invention. The Gires-Tournois interferometer 108.2 comprises all the elements of the Gires-Tournois interferometer 108.1 (FIG. 1b) in addition to an optical length adjustment element 195. The optical length adjustment element 195 preferably comprises glass and is disposed within the cavity 110 at a certain "tilt" angle a with respect to the reflective surfaces 120 and 140. The optical path length L_0 between the reflective surfaces 120 and 140 depends, in part, on the optical path length L_{195} through the optical length adjustment element 195. This quantity L_{195} is, in turn, related to the physical path length of signals 104-105 through the element 195 as well as the refractive index of element 195. Since, this physical path length depends upon the tilt angle α of element 195, then it follows that the quantity L_{195} and the quantity L_0 depend upon the angle α. Thus, by adjusting the angle α, it is possible to control

> the "phase" of the periodic curve of the chromatic dispersion produced by constructive and destructive interference within the cavity 110. The angle a may be set during manufacture or may be adjustable by means of a mechanical tilt adjustment so that the chromatic dispersion periodicity may be varied during operation of the dispersion compensator 100.
>
> FIG. 1d illustrates a third preferred embodiment of a Gires-Tournois interferometer that may be utilized within the chromatic dispersion compensator in accordance with the present invention. The Gires-Tournois interferometer 108.3 comprises all the elements of the Gires-Tournois interferometer 108.1 (FIG. 1b) in addition to a piezoelectric element 122 attached to the second glass plate 180B. Instead of being disposed on the second glass plate 180B, the 100% reflective surface 120 comprising the Gires-Tournois interferometer 108.3 is disposed upon the piezoelectric element 122 facing into the cavity 110. By controlling a voltage applied across the piezoelectric element 122, the variable thickness t of the piezoelectric element 122 may be very accurately controlled. This property of piezoelectric materials is well known. In this fashion, the optical path length L_0 between the reflective surfaces 120 and 140 may be controlled. Thus, by adjusting the thickness t, it is possible to control the "phase" of the periodic curve of the chromatic dispersion produced by constructive and destructive interference within the cavity 110. (Col. 4, line 60 - col. 6, line 28)

Recent Avanex PowerShaper™ Field Trials

Approximately thirty-four (34) months after Avanex Corporation issued the July 19, 2000, press release regarding the "Common Specification for VIPA-Type Dispersion Compensation Modules," on May 11, 2004, Avanex Corporation issued yet another press release entitled "Avanex's Patented Dispersion Compensation Solution Shipped to More Than 20 Customers for Trials and Deployments."[12] Pertinent portions of the May 11, 2004, Avanex Corporation press release state:

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12 See Exhibit L hereto which contains a copy of the Avanex Corporation's press release.

1. that its PowerShaper(TM) Fixed Dispersion Etalon Compensator, based on Avanex's patented Frequency Dispersion Synthesizer (FDS) technology, has been shipped to more than 20 customers for trials and field deployments;
2. Avanex announced early last year that it had been awarded a U.S. patent under the title "Method, system and apparatus for chromatic dispersion compensation utilizing a Gires-Tournois interferometer;"
3. this patent demonstrates the concept, method and design to achieve chromatic dispersion compensation using cascaded Gires-Tournois etalons; and
4. Avanex's FDS technology is based upon a cascade of etalons, which allows the customized design of a variety of dispersion profiles, including positive and negative dispersion and dispersion slopes, non-linear dispersion slopes and slope-only dispersion compensation.

Current Avanex PowerShaper™ Product

Exhibit M attached hereto is a copy of Avanex Corporation's data sheet for its PowerShaper™ **fixed** Dispersion Etalon Compensator. The Avanex Corporation data sheet states that the dispersion compensator is based upon Avanex's patented cascaded Gires-Tournois etalon technology.

Current Fujitsu Products

Exhibits N and O attached hereto reproduce Fujitsu Limited most recent literature describing its Flashwave® 4500-V6 and 7500 platforms. Fujitsu's Flashwave® 4500-V6 platform delivers a carrier-class, multiservice optical transport solution for telecom, Multiple System Operator (MSO), and wireless network system providers. Fujitsu's Flashwave® 7500 all optical networking platform is optimized for access, metro and regional Dense Wavelength Division Multiplexing (DWDM) networks.

With respect to dispersion compensation, the attached literature describing Fujitsu's Flashwave® 4500-V6 and 7500 platforms, respectively on page 3 thereof, mention only Netstender 1020 and 2060 systems sold by BTI Photonic Systems, Inc. of Ottawa, Ontario, Canada.

Approximately two (2) months before Fujitsu Limited's October 16, 2002, press release announcing transmission of 40 Gbps per channel over legacy optical fiber cable using a VIPA variable dispersion compensator, an August 20, 2002, press release by BTI

Photonic Systems, Inc. announced the availability of its ultra-compact Dispersion Compensation Modules (DCM).[13]

Dispersion Compensation Remains A Problem For Fiber Optic Communication Systems

Lastly, Exhibit Q attached hereto is an agenda for a session of the "30th European Conference on Optical Communication" held September 5-9, 2004, listing presentations to be given then which address the issue of dispersion compensation in fiber optic communication systems.

Exhibit T attached hereto contains abstracts from the OFC/NFOEC 2005 conference held March 7-11, 2005, in Anaheim, California. Exhibit R contains at least three (3) abstracts from the March 9-11 meetings, respectively on pages 16, 27 and 51 of Exhibit R, which report new approaches to chromatic dispersion compensation.

[13] See Exhibit P hereto which contains a copy of the BTI Photonic Systems, Inc.'s press release.

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **09-043057**

(43)Date of publication of application : **14.02.1997**

(51)Int.Cl. G01J 3/26

(21)Application number : **07-190535**

(22)Date of filing : **26.07.1995**

(71)Applicant : **FUJITSU LTD**

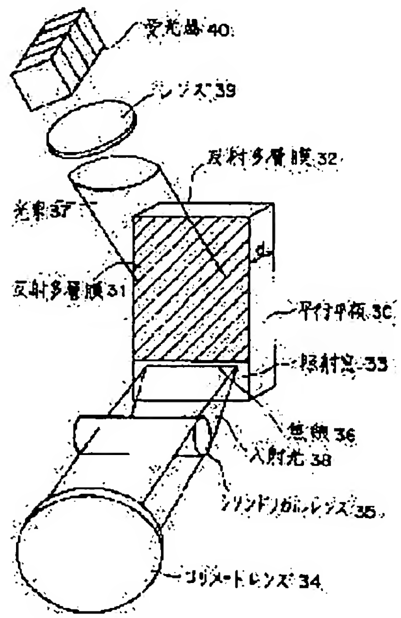
(72)Inventor : **SHIRASAKI MASATAKA**

(54) WAVELENGTH DIVIDER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a wave divider which can separate a plurality of light beams at a time, provides a relatively large dispersion angle, has a simple structure and is excellent in resistance against environments.

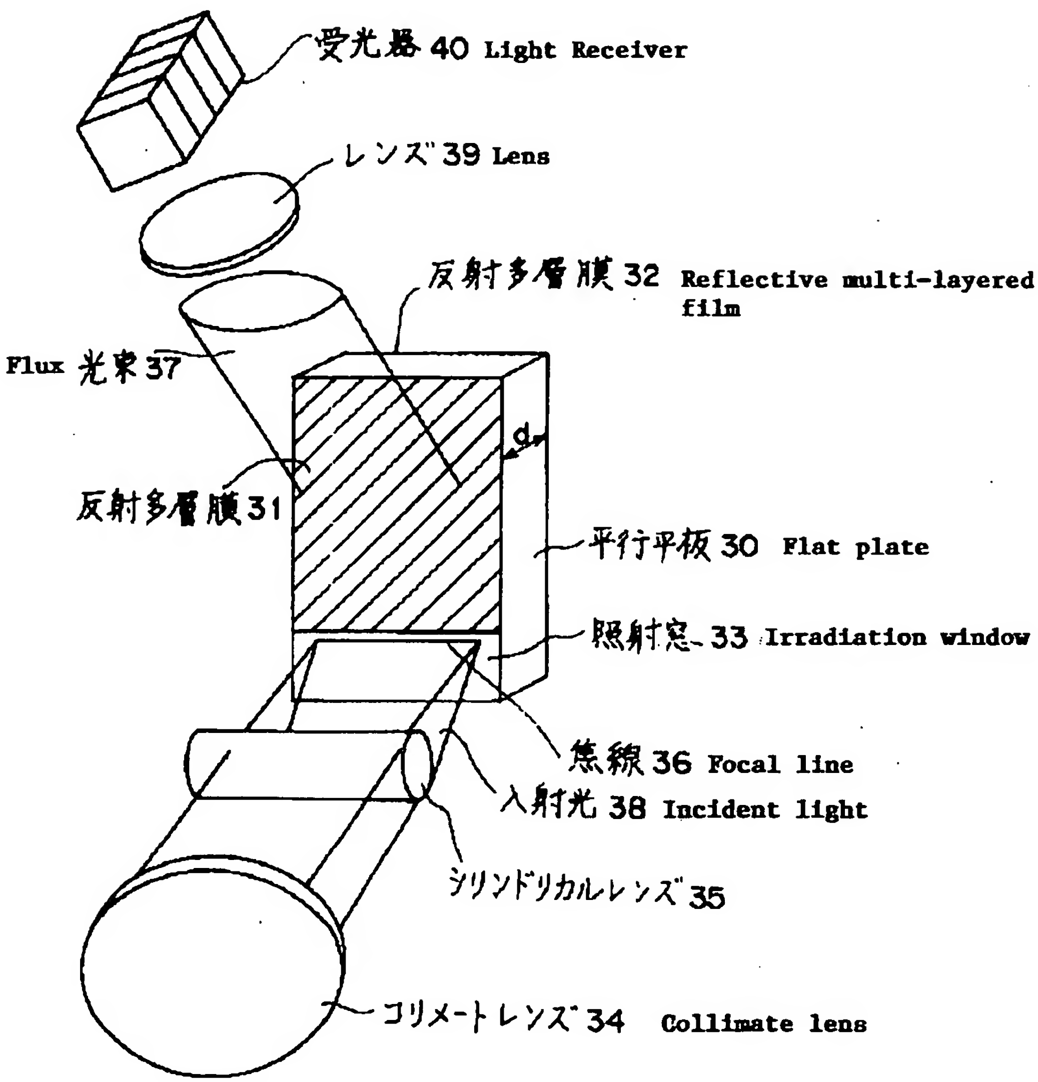
SOLUTION: A reflective multi-layered film 32 having reflectance of approximately 100% is provided on one of faces of a parallel flat plate 30 made of glass or the like, while a reflective multi-layered film 31 having reflectance less than 100% is provided on the other face. An irradiation window 33 having reflectance of approximately 0% is provided on the face with the film 31 provided to allow incident light 38 to be received. The incident light 38 has light made into parallel light by a collimate lens 34 condensed on a focal line 36 on the irradiation window and repeats multiple reflection while being spread in the parallel flat plate 30. At every reflection from the reflective multi-layered film 32, a part of the light is emitted outside to cause interference to form a flux 37. The flux 37 is emitted with a different angle for each light wavelength, and after being condensed by the lens 39, the flux 37 is detected by a light receiver 40 for each wavelength.



LEGAL STATUS

[Date of request for examination]	25.01.2002
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3464081
[Date of registration]	22.08.2003
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

本発明の一実施例を示す斜視図



USPTO PATENT FULL-TEXT AND IMAGE DATABASE

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Searching 1976 to present...

Results of Search in 1976 to present db for:
(((AN/Fujitsu AND TTL/virtually) AND TTL/imaged) AND TTL/phased): 20 patents.
Hits 1 through 20 out of 20

[redacted]

[redacted] AN/Fujitsu AND TTL/virtually AND TTL/imaged AN

	PAT. NO.		Title
1	6,786,611	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
2	6,781,758	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
3	6,717,731	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
4	6,607,278	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
5	6,481,861	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
6	6,478,433	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
7	6,471,361	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
8	6,390,633	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
9	6,343,866	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
10	6,332,689	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
11	6,296,361	T	Optical apparatus which uses a virtually imaged phased array to produced chromatic dispersion
12	6,185,040	T	Virtually imaged phased array (VIPA) having spacer element and optical length adjusting element
13	6,169,630	T	Virtually imaged phased array (VIPA) having lenses arranged to provide a wide beam width
14	6,144,494	T	Virtually imaged phased array (VIPA) having spacer element and optical length adjusting element
15	6,028,706	T	Virtually imaged phased array (VIPA) having a varying reflectivity surface to improve beam profile
16	5,999,320	T	Virtually imaged phased array as a wavelength demultiplexer
17	5,973,838	T	Apparatus which includes a virtually imaged phased array (VIPA) in combination with a wavelength splitter to demultiplex wavelength division multiplexed (WDM) light
18	5,969,866	T	Virtually imaged phased array (VIPA) having air between reflecting surfaces
19	5,969,865	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion
20	5,930,045	T	Optical apparatus which uses a virtually imaged phased array to produce chromatic dispersion

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September 13, 1999

Mr. Walter Alessandrini
Chief Executive Officer
Avanex Corporation
42501 Albrae Street
Fremont, CA 94538
USA

Re: Patent License Agreement on VIPA between Fujitsu Limited and Avanex Corporation

Dear Mr. Alessandrini:

Fujitsu Limited acknowledges that, as of September 13, 1999, the Conditions Precedent in Section 2 of the above Patent License Agreement have been fulfilled for dispersion compensator and the patent license for the same has been granted to Avanex Corporation.

I appreciate your business.

Sincerely,

/s/ Yasuo Nagai

Yasuo Nagai
General Manager
Photonic Technology Development Division
Fujitsu Limited
4-1-1 Kamikodanaka, Nakahara-ku
Kawasaki, 211-8588
Japan

PATENT LICENSE AGREEMENT

THIS AGREEMENT is made and entered into by and between FUJITSU LIMITED, a corporation of Japan, having its registered office at 4-1-1 Kamikodanaka, Nakahara-ku, Kawasaki, Kanagawa, 211-88, Japan (hereinafter referred to as "FUJITSU"), and AVANEX Corporation, a corporation of the State of California, having its principal office at 42501 Albrae Street, Fremont, CA 94538, USA. (hereinafter referred to as "AVANEX").

WITNESSETH

WHEREAS, FUJITSU owns patents in certain countries of the world with respect to LICENSED PRODUCTS (defined below); and

WHEREAS, AVANEX desires to acquire licenses under such FUJITSU's patents; and

WHEREAS, FUJITSU is willing to grant such licenses to AVANEX.

NOW, THEREFORE, in consideration of the mutual covenants and premises contained herein, the parties hereto agree as follows:

Section 1. DEFINITIONS

Finance
Corporate Governance
E-Business & Internet
Environmental
Government Relations
Intellectual Property
International
Labor & Employment
Litigation
Mergers & Acquisition
Privacy & Security
Securities
Securities Litigation
Tax
Tax-Exempt Organizations
White Collar Crime
More Centers...

1.1 "SUBSIDIARY(IES)" shall mean any corporation, company or other entity more than fifty percent (50%) of whose voting stock or other similar interests are owned or controlled by AVANEX, directly or indirectly, as of EFFECTIVE DATE (defined below) and thereafter so long as such ownership or control exists.

1.2 "LICENSED PRODUCTS" shall mean the following items (1) and (2):

(1) Wavelength multiplexer/demultiplexer devices which consist of the VIPA element.

(2) Chromatic dispersion compensator devices which consist of the VIPA element and a mirror.

1.3 "LICENSED PATENTS" shall mean all the patents issued under the following patent applications and their divisions, continuations and continuation-in-parts, and all reissues of any of the foregoing patents: [*]

1.4 "LICENSED TERRITORIES" shall mean the countries in which LICENSED PATENTS are in existence.

1.5 "EFFECTIVE DATE" shall mean the date when all of the conditions of Section 2 are satisfied.

1.6 "DESIGN INFORMATION" shall mean the structural design information of LICENSED PRODUCTS, which includes design parameters and parts design sheets, but does not include the assembling know-how. FUJITSU can freely use this DESIGN INFORMATION for its own use.

Section 2. CONDITIONS PRECEDENT AND EFFECTIVENESS OF AGREEMENT

The license pursuant to Section 3 below shall become available only after all of the following conditions preceding have fulfilled for each LICENSED PRODUCT:

(a) Development by AVANEX of DESIGN INFORMATION used for LICENSED PRODUCTS in accordance with the specifications which will be given by FUJITSU to AVANEX, no later than one (1) month from the day when this agreement is signed by both parties, pursuant to a separate confidential agreement. AVANEX shall perform such development for FUJITSU with the first priority before manufacturing LICENSED PRODUCTS for customers other than FUJITSU.

(b) DESIGN INFORMATION is given to FUJITSU with [*] charge.

Section 3. GRANTS OF LICENSES

3.1 FUJITSU hereby grants for the term of this Agreement to AVANEX, subject to the

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* Certain information on this page has been omitted and filed separately with the Commission. Confidential treatment has been requested with respect to the omitted portions.

conditions under Section 4 below, a non-exclusive and non-transferable license, without the right to sublicense, under LICENSED PATENTS to make or have made LICENSED PRODUCTS and to use, lease, sell, offer to sell, import or otherwise dispose of such LICENSED PRODUCTS in LICENSED TERRITORIES.

3.2 The license granted to AVANEX hereunder shall also extend to any of SUBSIDIARY provided that AVANEX shall cause SUBSIDIARIES to assume the same obligations as imposed on AVANEX hereunder.

Section 4. LICENSES FEE

4.1 In consideration of the license set forth in Section 3 above, AVANEX shall, beginning on the EFFECTIVE DATE and to the extent that AVANEX and SUBSIDIARIES manufacture, have manufactured, use, lease, sell, offer to sell, import or otherwise dispose of LICENSED PRODUCTS under this Agreement, pay to FUJITSU a running royalty of [*] of all NET SALES AMOUNT (hereinafter defined) of all LICENSED PRODUCTS which are made or had made, and used, leased, sold, imported or otherwise disposed of by AVANEX and SUBSIDIARIES in LICENSED TERRITORIES.

4.2 For the purpose of this Agreement, "NET SALES AMOUNT" shall mean the total of the arm's length selling prices of LICENSED PRODUCTS at which distributors, dealers, customers and users of AVANEX or SUBSIDIARIES paid, but the following

items may be excluded; normal discounts actually granted, insurance fees and packing and transportation charges as invoiced separately to customers, and duties and sales taxes actually incurred and paid by AVANEX or SUBSIDIARIES. If LICENSED PRODUCTS are used, leased, imported or otherwise disposed of by AVANEX or SUBSIDIARY, or sold by AVANEX or SUBSIDIARY not on arm's length basis, the selling prices used in calculating NET

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SALES AMOUNT shall be the average arm's length selling prices during the past [*] for the same or similar LICENSED PRODUCTS sold by AVANEX or SUBSIDIARIES to third party customers.

Section 5. PAYMENTS, REPORTS, RECORDS AND TAX

5.1 The running royalty set forth in Section 4.1 above shall be computed and paid to FUJITSU by AVANEX within thirty (30) days after the end of each quarter ending on March 31st, June 30th, September 30th and December 31st.

5.2 AVANEX shall, at the time of each payment of the running royalty under Section 5.1 above, furnish to FUJITSU a royalty report in suitable form prepared by Chief Financial Officer of AVANEX, which shall describe sales (including use, lease, import or other disposition) quantity and gross sales price of LICENSED PRODUCTS, any deduction from and/or adjustments to the gross sales price as provided in Section 4.2 above, NET SALES AMOUNT, royalty amount, tax withheld and royalty remitted. AVANEX shall, within sixty (60) days after the end of each calendar year, also furnish to FUJITSU a royalty compliance report certified by an outside Certified Public Accountant, for the period of the year.

5.3 The first royalty report and payment shall be made with respect to all LICENSED PRODUCTS made or had made, and used, leased, sold, import or otherwise disposed of by AVANEX and SUBSIDIARIES in LICENSED TERRITORIES from EFFECTIVE DATE to the last day of the quarterly period next ending.

5.4 Payment hereunder shall be made without deductions of taxes, assessments or other charges of any kind which may be imposed on FUJITSU by the Government of the United States of America or any political subdivision thereof with respect to any amounts due to FUJITSU pursuant to this Agreement, and such taxes, assessments or other charges shall be paid by AVANEX. However, income taxes or taxes of similar nature imposed on FUJITSU by the Government of the United States of America or any other political subdivision thereof and paid by AVANEX for the account of FUJITSU shall be deductible from the payment to FUJITSU to the extent that such taxes are allowable as a credit against taxes imposed on FUJITSU by the Government of Japan. To assist FUJITSU in obtaining such credit, AVANEX shall furnish FUJITSU with such evidence as may be required by taxing authorities of the Government of Japan to establish that any such taxes have been paid.

5.5 If AVANEX fails to make any payment stipulated in this Agreement within the time specified herein, AVANEX shall pay an interest of fifteen percent (15%) per year on the unpaid balance payable from the due date until fully paid. The foregoing payment of interest shall not affect FUJITSU's right to terminate this Agreement in accordance with Section 7.2 below.

5.6 Any payment from AVANEX to FUJITSU hereunder shall be made by means of telegraphic transfer remittance in U.S. Dollars to the following bank account of FUJITSU, and notice of the payment shall be sent by AVANEX to FUJITSU's address set forth in Section 8.6 below:

The Dai-Ichi Kangyo Bank, Ltd., Head Office, Tokyo, Japan
Account No. 011-1-167829

Section 6. ACCOUNTING AND AUDIT

With respect to the running royalty set forth in Section 4.1 above, AVANEX shall keep full, clear and accurate records and accounts for LICENSED PRODUCTS subject to royalty for a period of three (3) years. FUJITSU shall have the right through a person(s) appointed by FUJITSU to audit, not more than once in each calendar year and during normal business hours, all such records and accounts to the extent necessary to verify that no underpayment has been made by AVANEX hereunder. Such audit shall be conducted at FUJITSU's own expense, provided that

if any discrepancy or error exceeding five percent (5%) of the money actually due is found through the audit, the cost of the audit shall be born by AVANEX.

Section 7. TERM AND TERMINATION

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* Certain information on this page has been omitted and filed separately with the Commission. Confidential treatment has been requested with respect to the omitted portions.

7.1 This Agreement shall become effective on EFFECTIVE DATE and shall, unless earlier terminated pursuant to Sections 7.2 or 7.3 below, continue until [*].

7.2 In the event of a breach of this Agreement by one party hereto, and if such breach is not corrected within ninety (90) days after written notice complaining thereof is received by such party, the other party may terminate this Agreement forthwith by written notice to that effect to such party.

7.3 FUJITSU shall also have the right to terminate this Agreement forthwith by giving written notice of termination to AVANEX at any time, upon or after:

(a) the filing by AVANEX of a petition in bankruptcy or insolvency; or

(b) any adjudication that AVANEX is bankrupt or insolvent; or

(c) the filing by AVANEX of any legal action or document seeking reorganization, readjustment or arrangement of AVANEX's business under any law relating to bankruptcy or insolvency; or

(d) the appointment of receiver for all or substantially all of the property of AVANEX; or

(e) the making by AVANEX of any assignment for the benefit of creditors; or

(f) the institution of any proceedings for the liquidation or winding up of AVANEX's business or for the termination of its corporate charter; or

(g) the assignment to third party of all or substantially all of the assets of AVANEX; or

(h) important change in controlling ownership of AVANEX; or

(i) any activity or assistance by AVANEX or SUBSIDIARIES of challenging the validity of any LICENSED PATENTS or restricting the scope thereof.

7.4 In the event of termination of this Agreement by FUJITSU pursuant to Sections 7.2 or 7.3 above, the licenses granted hereunder to AVANEX and SUBSIDIARIES shall automatically terminate when AVANEX received or deemed to be received such termination notice hereunder. AVANEX shall pay the amount of the running royalty accrued on or before the date of termination within thirty (30) days thereafter.

Section 8. NEW PATENTS

A new patent derived from any improvement over inventions covered by the LICENSED PATENTS:

(i) is owned by FUJITSU and the non-exclusive license shall be granted to AVANEX at a reasonable royalty, if invention is made solely by FUJITSU. Detailed terms and conditions for such license shall be separately agreed upon between the parties.

(ii) is owned by AVANEX and the non-exclusive license shall be granted to FUJITSU at a reasonable royalty, if invention is made solely by AVANEX. Detailed terms and conditions for such license shall be separately agreed upon between the parties. However, the non-exclusive license for a patent for which the invention is made within [*] after the day when this agreement is signed by both parties shall be royalty free.

(iii) is owned jointly by FUJITSU and AVANEX, if invention is made by FUJITSU and AVANEX. Each party shall be free to practice and use such jointly owned patent on a world-wide, non-exclusive basis without accounting to and royalty-free to the-other party. Each party shall be free to license jointly owned patent to SUBSIDIARIES but licenses to third parties may be granted only upon the other party's prior consent, which may not be unreasonably withheld.

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* Certain information on this page has been omitted and filed separately with the Commission. Confidential treatment has been requested with respect to the omitted portions.

Section 9. SAMPLE PRODUCT

Upon the conditions Section 2(a) and Section 2(b) have been fulfilled for each LICENSED PRODUCT, AVANEX shall sell 3 sets of LICENSED PRODUCT's samples to FUJITSU, if FUJITSU wishes to purchase. Such product's samples shall be made based on DESIGN INFORMATION given to FUJITSU and their performance shall be in accordance with the specifications set forth in Section 2(a). The purchase shall be with a separate purchase order.

Section 10. MISCELLANEOUS

10.1 The parties hereto shall keep the terms and conditions of this Agreement (except the existence of this Agreement) confidential and shall not divulge the same or any part thereof to any third party except:

(i) with the prior written consent of the other party; or

(ii) to any governmental body having jurisdiction to request and to read the same; or

(iii) as otherwise may be required by law or legal process; or

(iv) to legal counsel representing either party; or

(v) as required for review by the competent authorities of the Japanese or the U.S. Government.

10.2 The construction and performance of this Agreement shall be governed by and shall be subject to the laws of Japan.

10.3 The parties hereto shall use their best efforts to resolve by mutual agreement any disputes, controversies or differences which may arise from, under, out of or in connection with this Agreement. If any such disputes, controversies or differences cannot be settled between the parties hereto, they shall be finally settled by arbitration in Tokyo, Japan under the Rules of International Chamber of Commerce and by three (3) arbitrators appointed in accordance with the said Rules. The award rendered by the arbitrators shall be final and binding upon the parties hereto. Judgment upon the award may be entered into any court having jurisdiction thereof.

10.4 Any failure of either party to enforce, at any time or for any period of time, any of the provisions of this Agreement shall not be construed as a waiver of such provisions or of the right of such party thereafter to enforce such provisions.

10.5 If any term, clause or provision of this Agreement shall be judged by the competent authority to be invalid, the validity of any other term, clause or provision shall not be affected; and such invalid term, clause or provision shall be deemed deleted from this Agreement.

10.6 All notices required or permitted to be given hereunder shall be sent in writing by certified or registered airmail, or facsimile (with a confirmation letter thereof) to the address specified below or to such changed address as may have been previously specified in writing by the addressed party:

If to FUJITSU: FUJITSU LIMITED
4-1-1 Kamikodanaka, Nakahara-ku
Kawasaki-shi, Kanagawa, 211-8588, Japan
Attention: General Manager, Industry Relations Division I (H043)
Facsimile No. +81-44-754-8503

If to AVANEX: AVANEX Corporation
42501 Albrae Street, Fremont, CA 94538, USA
Attention: Dr. Simon Cao, President
Facsimile No. +1-510-360-0689

Unless otherwise proven, each such notice given by either party hereto shall be

deemed to have been received by the other party on the fourteenth (14th) day following the mailing date or on the second (2nd) day following the facsimile date.

10.7 FUJITSU shall keep DESIGN INFORMATION disclosed by AVANEX confidential against any third party However, the obligations on FUJITSU set out in this Section 10.7 do not apply in respect of information:

(a) which is at any time in the public knowledge otherwise than through act or failure to act on the part of FUJITSU; or

(b) which was known to FUJITSU before its receipt of the same from AVANEX, without obligations of confidentiality; or

(c) which is at any time rightfully received by FUJITSU from any third party without obligations of confidentiality; or

(d) which is at any time developed by FUJITSU independently of confidential information.

The obligations set out in this Section 10.7 shall continue to bind FUJITSU for [*] after the disclosure of DESIGN INFORMATION.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be duly executed in duplicate on the date below written.

FUJITSU LIMITED	AVANEX Corporation
By: /s/ Yasuo Nagai	By: /s/ Simon Cao
Name: Yasuo Nagai	Name: SIMON CAO
Title: General Manager	Title: President
Date: 7/9/98	Date: 7/15/98

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* Certain information on this page has been omitted and filed separately with the Commission. Confidential treatment has been requested with respect to the omitted portions.

Agreement on New Patents

This Agreement entered into as of August 26, 1998 by and between Fujitsu Limited, a corporation of Japan, having an address at 4-1-1, Kamikodanaka, Nakahara-ku, Kawasaki, Kanagawa, 211, Japan (hereinafter referred to as "Fujitsu"), and Avanex Corporation, a corporation of the State of California, having an address at 42501 Albrae Street, Fremont, CA 94538 (hereinafter referred to as "Avanex").

WHEREAS, Fujitsu and Avanex have executed a PATENT LICENSE AGREEMENT in July, 1998, regarding the VIPA technologies.

WHEREAS, Fujitsu and Avanex are willing to have Technical Discussions between the people from both parties regarding the VIPA technologies and other optics technologies.

NOW, THEREFORE, both Fujitsu and Avanex agree that all patents produced directly from the Technical Discussions stated above, regardless of whether the patents are related to the VIPA technologies or not, are subject to the conditions in the above mentioned PATENT LICENSE AGREEMENT, Section 8. NEW PATENTS.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the day above written.

Fujitsu Limited	Avanex Corporation
/s/Hideki Isono	/s/ Simon Cao
Hideki Isono Manager Photonic Devices Development Dept.	Simon Cao President and CEO

TYPE: EX-10.24.1
SEQUENCE: 30
DESCRIPTION: LETTER CLARIFYING THE PATENT LICENSE AGREEMENT

1

EXHIBIT 10.24.1

July 1, 1998

Dr. Simon Cao
President
Avanex Corporation
42501 Albrae Street
Fremont, CA 94538
USA

Re: Patent License Agreement for the VIPA related devices between Fujitsu Limited and Avanex Corporation

Dear Dr. Cao:

With regard to Section 7.3(h) of the agreement, Fujitsu Limited understands that this term is defined as below.

"important change in controlling ownership of AVANEX" means acquisition of more than half of Avanex Corporation by one of [*].

The [*] are defined as [*].

Sincerely,

/s/ Hideki Isono

Hideki Isono
Manager
Photonic Devices Development Dept.
Fujitsu Limited

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* Certain information on this page has been omitted and filed separately with the Commission. Confidential treatment has been requested with respect to the omitted portions.

USPTO PATENT FULL-TEXT AND IMAGE DATABASE

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Hits 1 through 9 out of 9

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	PAT. NO.		Title
1	6,744,991	T	Tunable chromatic dispersion and polarization mode dispersion compensator utilizing a virtually imaged phased array
2	6,714,705	T	Tunable chromatic dispersion and dispersion slope compensator utilizing a virtually imaged phased array and a rotating grating
3	6,668,115	T	Method, apparatus, and system for compensation of amplifier gain slope and chromatic dispersion utilizing a virtually imaged phased array
4	6,556,320	T	Tunable chromatic dispersion, dispersion slope, and polarization mode dispersion compensator utilizing a virtually imaged phased array
5	6,441,959	T	Method and system for testing a tunable chromatic dispersion, dispersion slope, and polarization mode dispersion compensator utilizing a virtually imaged phased array
6	6,392,807	T	Tunable chromatic dispersion compensator utilizing a virtually imaged phased array and folded light paths
7	6,363,184	T	Method and apparatus for chromatic dispersion compensation and dispersion slope compensation in wavelength division multiplexed systems utilizing a channel separator and virtually imaged phased arrays
8	6,310,993	T	Method and apparatus for chromatic dispersion compensation and dispersion slope compensation in wavelength division multiplexed systems utilizing a channel separator and virtually imaged phased arrays
9	6,301,048	T	Tunable chromatic dispersion and dispersion slope compensator utilizing a virtually imaged phased array

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**Excerpts From
United States Patents
Which Identify Masataka Shirasaki As an Inventor
And Which Are Assigned To
Fujitsu Limited
Having Titles Which Include the Phrase
"Virtually Imaged Phased Array"**

U.S. Pat. No. 5,930,045

Filed in U.S. February 7, 1997 as
CIP of U.S. application Ser. No. 08/685,362 filed July 24, 1996
Claims priority from JP 07-190535 Filed July 26, 1995

Referring now to FIG. 7, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength $\lambda 1$, VIPA 76 outputs a luminous flux 82a at wavelength $\lambda 1$ in a specific direction. When input light 77 is at a wavelength $\lambda 2$, VIPA 76 outputs a luminous flux 82b at wavelength $\lambda 2$ in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 5,969,865

Referring now to FIG. 7, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input

light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 5,969,866

Referring now to FIG. 7, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 5,973,838

Referring now to FIG. 6, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. If input

light 77 is a wavelength division multiplexed light which combines light at wavelength λ1 and light at wavelength λ1, then VIPA 76 simultaneously outputs two separate luminous fluxes 82a and 82b in different directions. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. In this manner, VIPA 76 can simultaneously separate two or more different carrier lights from a wavelength division multiplexed light. (Emphasis supplied.)

U.S. Pat. No. 5,999,320

FIG. 6 is a diagram illustrating a wavelength splitter, according to an embodiment Of the present invention. Moreover, hereinafter, the terms "wavelength splitter" and "virtually imaged phased array" may be used interchangeably.

Referring now to FIG. 6, a wavelength splitter 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into wavelength splitter 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside wavelength splitter 76. Wavelength splitter 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, wavelength splitter 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, wavelength splitter 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. If input light 77 is a wavelength division multiplexed light which combines light at wavelength λ1 and light at wavelength λ1, then wavelength splitter 76 simultaneously outputs two separate luminous fluxes 82a and 82b in different directions. Therefore, wavelength splitter 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. In this manner, wavelength splitter 76 can simultaneously separate two or more different carrier lights from a wavelength division multiplexed light. (Emphasis supplied.)

U.S. Pat. No. 6,028,706

Referring now to FIG. 6, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 inside VIPA 76. VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. If input light 77 includes both wavelengths λ1 and λ2, then VIPA 76 will simultaneously output both luminous fluxes 82a and 82b. (Emphasis supplied.)

U.S. Pat. No. 6,144,494

Referring now to FIG. 6, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 inside VIPA 76. VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. If input light 77 includes both wavelengths λ1 and λ2, then VIPA 76 will simultaneously output both luminous fluxes 82a and 82b. (Emphasis supplied.)

U.S. Pat. No. 6,169,630

Referring now to FIG. 6, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 inside VIPA 76. VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. If input light 77 includes both wavelengths λ1 and λ2, then VIPA 76 will simultaneously output both luminous fluxes 82a and 82b. (Emphasis supplied.)

U.S. Pat. No. 6,185,040

Referring now to FIG. 6, a VIPA 76 is preferably made of a thin plate of glass. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 inside VIPA 76. VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. If input light 77 includes both wavelengths λ1 and λ2, then VIPA 76 will simultaneously output both luminous fluxes 82a and 82b. (Emphasis supplied.)

U.S. Pat. No. 6,296,361

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, Ad VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,332,689

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,343,866

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,390,633

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,471,361

> Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,478,433

> Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,481,861

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength $\lambda 1$, VIPA 76 outputs a luminous flux 82a at wavelength $\lambda 1$ in a specific direction. When input light 77 is at a wavelength $\lambda 2$, VIPA 76 outputs a luminous flux 82b at wavelength $\lambda 2$ in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,607,278

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength $\lambda 1$, VIPA 76 outputs a luminous flux 82a at wavelength $\lambda 1$ in a specific direction. When input light 77 is at a wavelength $\lambda 2$, VIPA 76 outputs a luminous flux 82b at wavelength $\lambda 2$ in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially-distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,717,731

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,781,758

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ1, VIPA 76 outputs a luminous flux 82a at wavelength λ1 in a specific direction. When input light 77 is at a wavelength λ2, VIPA 76 outputs a luminous flux 82b at wavelength λ2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,786,611

Referring now to FIG. 7, **a VIPA 76 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. VIPA 78 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength $\lambda 1$, VIPA 76 outputs a luminous flux 82a at wavelength $\lambda 1$ in a specific direction. When input light 77 is at a wavelength $\lambda 2$, VIPA 76 outputs a luminous flux 82b at wavelength $\lambda 2$ in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b which are spatially distinguishable from each other. (Emphasis supplied.)

Excerpts From
United States Patents
Assigned To Only
Avanex Corporation[14]
Having Titles Which Include the Phrase
"Virtually Imaged Phased Array"

U.S. Pat. No. 6,301,048

FIG. 3 illustrates a virtually imaged phased array of the first preferred embodiment of the chromatic dispersion and dispersion slope compensator in accordance with the present invention. The VIPA 206 is disclosed in U.S. Pat. No. 5,930,045, incorporated herein by reference. **The VIPA 206 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 206**. Line 78 is hereinafter referred to as the "focal line". Input light 77 radially propagates from focal line 78 to be received inside VIPA 206. The VIPA 206 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 206 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 206 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 206 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,310,993

Referring now to FIG. 9, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. The VIPA 76 then outputs a luminous flux 82 of collimated

[14] Fujitsu Limited and Avanex Corporation jointly own 13 United States Patents every one of which identifies Masataka Shirasaki as an inventor.

light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 76 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 76 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,363,184

Referring now to FIG. 9, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. The VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 76 outputs a luminous flux 82a at wavelength λ_1, in a specific direction. When input light 77 is at a wavelength λ_2 VIPA 76 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,392,807

Referring now to FIG. 1, **a VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a cylindrical lens or semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. The VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 76 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 76 outputs a luminous flux 82b at wavelength λ_2 in a different

direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,441,959

FIG. 2 illustrates a VIPA utilized in the preferred embodiments of the dispersion and dispersion compensator in accordance with the present invention. The VIPA 76 is disclosed in U.S. Pat. No. 5,930,045, incorporated herein by reference. **The VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is herein after referred to as "focal line". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. The VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_i, VIPA 76 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 76 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,556,320

FIG. 2 illustrates a VIPA utilized in the preferred embodiments of the dispersion and dispersion compensator in accordance with the present invention. The VIPA 76 is disclosed in U.S. Pat. No. 5,930,045, incorporated herein by reference. **The VIPA 76 is preferably made of a thin plate of glass**. **An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. The VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 76 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 76 outputs a luminous flux 82b at

wavelength λ_2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,668,115

Referring now to FIG. 10, **a VIPA 76 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 76**. Line 78 is hereinafter referred to as "focal line 78". Input light 77 radially propagates from focal line 78 to be received inside VIPA 76. The VIPA 76 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 76 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 76 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 76 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,714,705

The understanding of the operation of the VIPA 206 is central to the understanding of the functioning of the compensator 200 and the role of mirror curvature in determining the magnitude and sign of the provided chromatic dispersion. Therefore, FIGS. 3-7B provide additional details of the construction and operation of the VIPA 206. The VIPA apparatus is also disclosed in U.S. Pat. No. 5,930,045, incorporated herein by reference. FIG. 3 illustrates **the VIPA 206, which is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a line focusing lens 204, such as a cylindrical or semi-cylindrical lens, so that input light 77 travels into VIPA 206**. Line 78 is herein referred to as the "focal line". Input light 77 radially propagates from focal line 78 to be received inside VIPA 206. The VIPA 206 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 206 outputs a luminous flux 82a at wavelength λ_1 in a specific direction.

When input light 77 is at a wavelength λ_2, VIPA 206 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 206 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

U.S. Pat. No. 6,744,991

FIG. 3 illustrates a virtually imaged phased array (VIPA) of the first preferred embodiment of the chromatic dispersion and PMD compensator in accordance with the present invention. The VIPA 206 is disclosed in U.S. Pat. No. 5,930,045, incorporated herein by reference. **The VIPA 206 is preferably made of a thin plate of glass. An input light 77 is focused into a line 78 with a lens 80, such as a semi-cylindrical lens, so that input light 77 travels into VIPA 206.** Line 78 is hereinafter referred to as "focal line". Input light 77 radially propagates from focal line 78 to be received inside VIPA 206. The VIPA 206 then outputs a luminous flux 82 of collimated light, where the output angle of luminous flux 82 varies as the wavelength of input light 77 changes. For example, when input light 77 is at a wavelength λ_1, VIPA 206 outputs a luminous flux 82a at wavelength λ_1 in a specific direction. When input light 77 is at a wavelength λ_2, VIPA 206 outputs a luminous flux 82b at wavelength λ_2 in a different direction. Therefore, VIPA 206 produces luminous fluxes 82a and 82b that are spatially distinguishable from each other. (Emphasis supplied.)

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Hilton Anaheim, Pacific Ballroom

Service Provider Summit

8:30 a.m.–9:00 a.m. **Keynote Presentation I: FTTP Deployment in Today's Market**
Greg Evans, Vice President, Services & Access Technologies, Verizon, USA

9:00 a.m.–10:30 a.m **Panel I: Access Networks of the Future**
Moderator: *Scott Clavenna, Chief Analyst, Heavy Reading, USA*
Speakers:
- *Jim Mollenkopf, Vice President, Architecture and Products, Current Technologies, USA*
- *Steven Jackson, Director, Network Architecture and Standards, MCI, USA*
- *Yasuyuki Okumura, Executive Manager, NTT Access Network Service Systems Labs, Japan*
- *Mo Shakouri, Vice President WiMax Forum, USA; AVP Business Development, Alvarion, USA*
- *Vincent O'Byrne, Director, Wireline Access Technology, Verizon, USA*

11:00 a.m.–11:30 a.m. **Keynote Presentation II: The Evolution of Enterprise Data Requirements**
Brian Van Steen, Senior Analyst, RHK, USA

11:30 a.m.–1:00 p.m. **Panel II: Optics Enabling Business Applications—Data, Voice and Video**
Moderator: Ann Von Lehmen, Telcordia Technologies, USA
Speakers:
- *Albert Broscius, Vice President, Morgan Stanley & Co., USA*
- *Jim Brinksma, Vice President Network Products & Strategy, Goldman Sachs & Co., USA*

1:00 p.m.–1:15 p.m. **Case Study Presentation**

(See pages 4–6 for details.)

10:00 a.m.–5:00 p.m. EXHIBIT HALL OPEN

10:00 a.m.–12:30 p.m. EXHIBIT-ONLY TIME

12:30 p.m.–1:30 p.m. LUNCH BREAK (On Your Own)

Ballroom A

1:30 p.m.–3:30 p.m.
OWA • Ultra Long-Haul Transmission
Harshad P. Sardesai; Ciena Corp., USA, Presider

OWA1 • 1:30 p.m. Invited
The Mars Laser Communications Demonstration Project: Truly Ultralong-Haul Optical Transport, *Don Boroson[1], Chien-Chung Chen[2], Bernard Edwards[3]; [1]MIT Lincoln Lab, USA, [2]JPL, USA, [3]NASA Goddard Space Flight Ctr., USA.* We present an overview of the Mars Laser Communications Demonstration, a joint project between NASA, JPL, and MIT Lincoln Laboratory. MLCD's goal is to demonstrate the first high-rate, free-space laser communications link from deep space back to Earth.

Ballroom B

1:30 p.m.–3:30 p.m.
OWB • Systems and Applications
Thomas Wood; Lucent Technologies, USA, Presider

OWB1 • 1:30 p.m.
A 400Gbps Backplane Switch with 10Gbps/Port Optical I/O Interfaces Based on OIP (Optical Interconnection as IP of a CMOS Library), *Kazunori Miyoshi, Ichiro Hatakeyama, Jun'ichi Sasaki, Keisuke Yamamoto, Mitsuru Kurihara, Takanori Watanabe, Jun Ushioda, Youichi Hashimoto, Ryousuke Kuribayashi, Kazuhiko Kurata; NEC Corp., Japan.* A 400Gbps backplane switch was developed with low-cost, small-size, 8-channels 10Gbps/port optical I/O and a SiGe Bi-CMOS switch LSI on a 60x60-mm-square BGA package. It indicates the applicability of OIP for high throughput backplane interconnections.

OWB2 • 1:45 p.m.
Using Optical Frequency Multiplication to Deliver a 17 GHz 64 QAM Modulated Signal to a Simplified Radio Access Unit Fed by Multimode Fiber, *A. Ng'oma, A. M. J. Koonen, I. Tafur Monroy, H.P.A. vd. Boom, G. D. Khoe; COBRA Inst., TU Eindhoven, Netherlands.* Using Optical Frequency Multiplication, simultaneous 3GHz to 17GHz carrier up-conversion and 64-QAM modulation with low EVM (4.6 %) is demonstrated. A simplified fiber wireless access unit fed by 4km multimode fiber is used.

Ballroom C

1:30 p.m.–3:30 p.m.
OWC • Optical Burst Switching
Mike O'Mahony; Univ. of Essex, UK, Presider

OWC1 • 1:30 p.m.
Performance Comparison of Optical Burst and Circuit Switched Networks, *Fei Xue[1], S. J. Ben Yoo[1], Hiroyuki Yokoyama[2], Yukio Horiuchi[2]; [1]Univ. of California at Davis, USA, [2]KDDI R&D Labs, Inc., Japan.* This paper presents quantitative performance comparisons between the OBS and OCS networks. The simulation results indicate that, under the identical traffic demand and network capacity, OBS networks achieve a higher throughput than OCS networks.

OWC2 • 1:45 p.m.
Does Optical Burst Switching Have a Role in the Core Network? *Rajendran Parthiban, Rodney S. Tucker, Chris Leckie, Andrew Zalesky, An Tran; Univ. of Melbourne, Australia.* We show that Optical Burst Switching (OBS) does not appear to be a viable option in the core network. In order to achieve an acceptably low blocking probability, OBS networks will require an uneconomically large increase in network transmission capacity.

Ballroom D

1:30 p.m.–3:30 p.m.
OWD • Nano-Photonics
G. Ronald Hadley; Sandia Natl. Labs, USA, Presider

OWD1 • 1:30 p.m. Invited
Ultra-High Q Microresonator Devices for Optical Communications, *Kerry Vahala, T. Kippenberg, D. Armani, S. Spillane, Lan Yang, Tal Carmon; Caltech, USA.* A new chip-based microcavity capable of Q factors as high as 500 million is reviewed. Fiber-coupled Raman and parametric oscillators having microWatt level threshold powers are demonstrated, as well as narrow-linewidth erbium lasers.

Notes

Ballroom E

1:30 p.m.–3:30 p.m.
OWE • Modulators
Ed Murphy; JDS Uniphase, USA, Presider

OWE1 • 1:30 p.m.
80Gb/s ETDM Transmitter with a Traveling-Wave Electroabsorption Modulator, *Yichuan Yu[1], Robert Lewén[1], Stefan Irmscher[1], Urban Westergren[1], Lars Thylén[1], Urban Eriksson[2], Thomas W. Lee[3]; [1]Royal Inst. of Technology, Sweden, [2]Optillion AB, Sweden, [3]SHF Communication Technologies AG, Germany.* We have demonstrated non-return-to-zero data transmission at 80Gb/s using an ETDM fiberoptical transmitter consisting of a segmented traveling-wave electroabsorption modulator with integrated termination resistor and a SiGe electronic multiplexer.

OWE2 • 1:45 p.m.
A 40Gb/s In-Line Co-Packaged Driver-Modulator, *Henri Porte[1], Jerome Hauden[1], Pascal Mollier[1], Nicolas Grossard[1], Filipe Jorge[2], Rene Lefevre[2], Sylvie Vuye[2], Dominique Baillargeat[3], Rosine Valois[3]; [1]Photline Technologies, France, [2]Alcatel-Thales III-V Labs, France, [3]IRCOM/Limoges Univ., France.* We fabricated a 40Gb/s In-line Co-Packaged GaAs Driver- $LiNbO_3$ Modulator. 40Gb/s optical eye-diagrams obtained with this compact module show openings of 75% and 78% with RMS jitters lower than 1ps.

Room 303A-B

1:30 p.m.–3:30 p.m.
OWF • Amplifier Materials
John Minelly; PriTel Inc., USA, Presider

OWF1 • 1:30 p.m. Invited
Recent Advances in Nanocrystal-Si Sensitized, Er-Doped Silica Waveguide Amplifiers, *Jung H. Shin[1], Se-Young Seo[1], Namkyoo Park[2], Hansuek Lee[2]; [1]KAIST, Republic of Korea, [2]Dept. of EECS, Seoul Natl. Univ., Republic of Korea.* Recent advances in nanocrystal-Si sensitized, Er-doped silica waveguide amplifier are introduced. Numerical performance analysis demonstrating its comparative advantages and commercial performance is presented, and ultra-broadband luminescence using a single pump-source and Er-Tm co-doping is demonstrated.

Room 303C-D

1:30 p.m.–3:30 p.m.
OWG • Network Design I
Neophytos Antoniades; CUNY, USA, Presider

OWG1 • 1:30 p.m.
ROADM Enabled Optimization in WDM Rings, *Pankaj Risbood, Carl Nuzman, Nachi Nithi, Sanjay Patel; Bell Labs, Lucent Technologies, USA.* Deployment of reconfigurable OADMs in WDM rings is expected to bring large operational savings. Such nodes also enable online network optimization; we quantify the potential savings as a function of element functionality and traffic churn.

OWG2 • 1:45 p.m.
Reliable Multi-Path Provisioning for Next-Generation SONET/SDH Networks with Virtual Concatenation, *Smita Rai[1], Omkar Deshpande[2], Canhui Ou[1], Biswanath Mukherjee[1]; [1]Univ. of California at Davis, USA, [2]Stanford Univ., USA, [3]SBC Services Inc., USA.* We propose *effective multi-path bandwidth* to provision a connection onto multiple paths while satisfying its availability requirement in next-generation SONET/SDH networks supporting virtual concatenation. Our proposal achieves lower blocking compared to the conventional single-path approach.

Room 304A-B

1:30 p.m.–3:30 p.m.
OWH • Multimode Fiber Applications
Dave Johnson; BTexact Technologies, UK, Presider

OWH1 • 1:30 p.m. Tutorial
Next Generation High-Speed Multimode Fiber Links and Their Specifications, *Petar K. Pepeljugoski; IBM Res., USA.* High speed multimode fiber (MMF) LAN links require specifications for both the MMF (Differential Mode Delay) and the laser (Encircled Flux). We describe the numerous engineering and commercial tradeoffs in developing these specifications that minimize the link failure rate.

Dr. Pepeljugoski is a Research Staff Member in the Communication Technology Department at the IBM Thomas J. Watson Research Center. He received his B.Sc. from University of Skopje, Macedonia in 1982, M.S. from University of Belgrade, Yugoslavia in 1986 and Ph.D. from the University of California at Berkeley in 1993. He joined IBM in 1994, where his research work included design, modeling, prototyping and characterization of high speed multimode fiber LAN links and parallel interconnects. His modeling tools were used by the Telecommunication Industry Association (TIA) in the development of the next generation fiber. He has been awarded IEEE recognition by the 10 Gigabit Ethernet Alliance for his contributions to the development of the 10 Gigabit Ethernet Standard. Dr. Pepeljugoski was also awarded Certificate of Appreciation by the TIA for his contri-

Exhibit Hall D

Market Watch

1:30 p.m.–3:30 p.m.
Delivering Convergence with Intelligent Ethernet Services

Moderator: *Mathew Steinberg, Director of Business Development, Ample Communications, USA*

Speakers:

- *Chuck Sullivan, Product Marketing Director, Data Networking Group, Ciena Corp., USA*
- *Mark Seery, Program Director, Switching and Routing, RHK, USA*
- *Matthew Liste, Vice President, Network Platform Engineering, Goldman, Sachs & Co., USA*

(See page 12 for details.)

Ballroom A

OWA • Ultra Long-Haul Transmission—Continued

OWA2 • 2:00 p.m.
Effects of DGE Bandwidth on Nonlinear ULH Systems, *Jay M. Wiesenfeld[1], Lara D. Garrett[1], Mark Shtaif[2], Michael H. Eiselt[1], Robert W. Tkach[1]; [1]Celion Networks, USA, [2]Tel-Aviv Univ., Israel.* Experiments and simulations show that the channel bandwidth of a dynamic gain-equalizer exerts strong influence on the performance of a nonlinear ULH system. For a 40-channel, 6000-km, 100 GHz-spaced, 12.5 Gb/s DWDM system, the optimal bandwidth is near 50 GHz.

OWA3 • 2:15 p.m.
Investigation of Cross Gain Modulation in 200-km Raman Amplified Spans with Bi-Directional Pumping, *Mei Du[1], Lynn Nelson[1], Peter B. Gaarde[2]; [1]OFS Labs, USA, [2]OFS, Denmark.* We have isolated and measured the impairment due to cross gain modulation in 200-km bi-directionally pumped fiber spans. The penalty depends on fiber dispersion characteristics and can be small for up to 20dB on-off co-gain.

OWA4 • 2:30 p.m.
Investigation of Cross Phase Modulation (XPM) Effect on Amplitude- and Phase-Modulated Multi-Level Signals in Dense-WDM Transmission, *Nobuhiko Kikuchi, Shinya Sasaki, Kenro Sekine, Toshiki Sugawara; Ctrl. Res. Lab, Hitachi Ltd., Japan.* The XPM effect on optical 8-ary APSK (Amplitude- and Phase- Shift Keying) multi-level signals is experimentally investigated, for the first time. Its feasibility is demonstrated in 0.48 Tbit/s (30 Gbit/s/ch) 50-GHz-spaced 16-channel dense-WDM 160-km unrepeatered transmission.

Ballroom B

OWB • Systems and Applications—Continued

OWB3 • 2:00 p.m.
Experimental Results on the Simultaneous Transmission of Two 2.5 Gbps Optical-CDMA Channels and a 10 Gbps OOK Channel within the Same WDM Window, *Stefano Galli, Ronald Menendez, Paul Toliver, Thomas Banwell, Janet Jackel, Jeff Young, Shahab Etemad; Telcordia Technologies, USA.* We propose and experimentally validate a novel coding technique that allows the simultaneous transmission of several OCDMA channels and a SONET channel in the same WDM window, thus obtaining a truly OCDMA-overlaid WDM system.

OWB4 • 2:15 p.m.
Multi-User, 10 Gb/s Spectrally Phase Coded O-CDMA System: Two Implementations, *Zhi Jiang[1], Dongsun Seo[1], Daniel E. Leaird[1], Andrew M. Weiner[1], Rostislav V. Roussev[2], Carsten Langrock[2], Martin M. Fejer[2]; [1]Purdue Univ., USA, [2]Stanford Univ., USA.* We have experimentally demonstrated 4-user, 10 Gb/s spectrally phase coded O-CDMA using low power nonlinear processing in two implementations, with emphasis on different coding schemes and requirements of timing coordination.

OWB5 • 2:30 p.m. Invited
ROADM Subsystems and Technologies, *Barrie P. Keyworth; JDS Uniphase, Canada.* ROADM subsystems can be implemented using a variety of architectures and technologies, each with trade-offs in performance and functionality. This paper describes the available technology options, and corresponding subsystem features, while highlighting key advantages and implementation challenges associated with each.

Ballroom C

OWC • Optical Burst Switching—Continued

OWC3 • 2:00 p.m. Invited
Optical Burst Switching Network Testbed in Japan, *Ken-ichi Kitayama[1], Masafumi Koga[2], Hiroyuki Morikawa[3], Shinsuke Hara[1], Masaaki Kawai[4]; [1]Osaka Univ., Japan, [2]NTT Corp., Japan, [3]Univ. of Tokyo, Japan, [4]Fujitsu Ltd., Japan.* A government-supported R&D initiative, "Optical Burst Switching Network" for five years, 2001-2005 is introduced. It is a comprehensive program, including the network architecture, wavelength reservation protocol, ultrafast processing of control packet, and switching fabric.

OWC4 • 2:30 p.m.
Flow Control and Congestion Management for Distributed Scheduling of Burst Transmissions in Time-Domain Wavelength Interleaved Networks, *Iraj Saniee[1], Indra Widjaja[1], Andrew Brzezinski[2], Eytan Modiano[2]; [1]Lucent Technologies, USA, [2]LIDS, MIT, USA.* This paper presents an algorithm for flow control and congestion management under the time-domain wavelength interleaved optical network architecture (described in [1]). The context of this algorithm is distributed scheduling for servicing asynchronously varying data streams.

Ballroom D

OWD • Nano-Photonics—Continued

OWD2 • 2:00 p.m.
Experimental Demonstration of Waveguides in Arrayed-Rod Photonic Crystals for Integrated Optical Buffers, *Masatoshi Tokushima; NEC Corp., Japan.* New arrayed-rod photonic-crystal (PC) waveguides suitable for micro optical buffers were fabricated. It is suggested that waveguides integrated in this PC can delay light with a wide range of wavelengths for several tens of nanoseconds.

OWD3 • 2:15 p.m.
Evanescent Wave Photonic Crystal Fiber Tunable Filter Using Dispersive Optical Polymers, *Nan-Kuang Chen[1], Sien Chi[2]; [1]Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan Republic of China, [2]Yuan Ze Univ., Taiwan Republic of China.* We demonstrate wideband tunable photonic crystal fiber filters based on dispersive evanescent wave tunneling. The wavelength tuning range is ~ 400 nm by 10°C temperature variation and extinction ratio of power is above 45 dB.

OWD4 • 2:30 p.m. Invited
Silicon Photonic Crystals and Photonic Wires for Ultradense Optical Integration, *Yurii Vlasov, S. J. McNab; IBM, TJ Watson Res. Ctr., USA.* We will review the latest results in the development of submicron silicon-on-insulator waveguiding structures–photonic crystals and single-mode strip waveguides (photonic wires).

Notes

Ballroom E

OWE • Modulators—Continued

OWE3 • 2:00 p.m. Invited
Integrated DQPSK Transmitters, *Robert Griffin; Bookham Technology, UK.* Integration of multiple functionality on a single chip has enabled the development of compact DQPSK transmitters for optical transmission. High performance and stable operation allow demonstration of the key attributes of the DQPSK format.

OWE4 • 2:30 p.m.
Return-Loss-Suppressed Electroabsorption Modulator with Novel Transmission Line Electrodes on Conductive Substrate, *Yuichi Akage, Hideki Fukano, Takayuki Yamanaka, Munehisa Tamura, Kenji Kishi, Hiroshi Okamoto, Hiroki Nakajima, Tadashi Saitoh, Yasuhiro Kondo; Nippon Telegraph and Telephone Corp., Japan.* An electroabsorption modulator with transmission line electrodes on an n-InP substrate has been newly designed and fabricated. We demonstrate clear eye opening at 40 Gbit/s with well-suppressed electrical return loss of less than -20 dB.

Room 303A-B

OWF • Amplifier Materials—Continued

OWF2 • 2:00 p.m.
Performance Optimization of Nanocrystal-Si Sensitized Er-Doped Waveguide Amplifier, *Hansuek Lee[1], Namkyoo Park[1], Se-Young Seo[2], Jung H. Shin[2]; [1]Seoul Natl. Univ., Republic of Korea, [2]KAIST, Republic of Korea.* We analyze the performance of nanocrystal-Si sensitized Erbium doped waveguide, and suggest novel structures, which can be used to enhance the performance figures.

OWF3 • 2:15 p.m.
Thulium Doped Fiber Amplifier for the First Window from 790nm to 850nm with 690nm/1400nm Dual Pumping, *Youichi Akasaka[1], Hiroyuki Inoue[2], Scott S. Yam[3], Yoshinori Kubota[4]; [1]Sprint, Advanced Technology Lab, USA, [2]Inst. of Industrial Science, Univ. of Tokyo, Japan, [3]Queen's Univ., Canada, [4]Optical Device Development, Ctrl. Glass Co., Ltd., Japan.* We demonstrate an optical amplifier with 30dB gain for the 850nm window using specialized fiber and practical pumping wavelengths of 690nm and 1400nm. The experimental results were achieved after thorough calculations made by Molecular-Dynamics simulation provided guidance on physical parameters.

OWF4 • 2:30 p.m.
Novel Pumping Scheme Study for Fluoride-Based Thulium-Doped Fiber Amplifier at 690 nm, *Scott S. Yam[1], Youichi Akasaka[2], Yoshinori Kubota[3], Hiroyuki Inoue[4], Krishnan Parameswaran[5]; [1]Queen's Univ., Canada, [2]Sprint Advanced Technology Labs, USA, [3]Optical Device Development, Central Glass Co. Ltd., Japan, [4]Inst. of Industrial Science, Univ. of Tokyo, Japan, [5]JDS Uniphase, USA.* Simultaneous pumping of thulium-doped fiber amplifier (TDFA) with 690nm and 1050nm (or 1400nm) is highly efficient and cost-competitive due to availability of 690nm digital video disk (DVD) laser diodes.

Room 303C-D

OWG • Network Design I—Continued

OWG3 • 2:00 p.m.
Prototype Demonstration of IP Multicasting over Optical Networks with Dynamic Point-to-Multipoint Configuration, *Weiqiang Sun[1], Yaohui Jin[1], Weisheng Hu[1], Hao He[1], Xuan Luo[1], Peigang Hu[1], Wei Guo[1], Yikai Su[1], Lufeng Leng[2]; [1]Shanghai Jiao Tong Univ., China, [2]CUNY, USA.* We demonstrate a novel overlay multicasting architecture: IP multicasting over optical networks with dynamic point-to-multipoint configuration. Experimental results show that the proposed architecture exhibits better performance than pure IP multicasting under heavy traffic load.

OWG4 • 2:15 p.m.
Performance Evaluation of Connection Setup in GMPLS IP Optical Network, *Qiang Song[1], Ibrahim Habib[1], Wesam Alanqar[2]; [1]CUNY, USA, [2]Sprint, USA.* This paper investigates the efficiency of deploying RSVP-TE for connection setup in GMPLS IP optical networks. The call blocking probability will be dramatically increased if the network-wide call inter-arrival time is within the concretion setup delay.

OWG5 • 2:30 p.m.
Dynamic Provisioning with Reliability Guarantee and Resource Optimization for Differentiated Services in WDM Mesh Networks, *Lei Song, Jing Zhang, Biswanath Mukherjee; Univ. of California at Davis, USA.* We present reliability analysis for shared-path-protected WDM mesh networks. We develop a cost-effective provisioning approach to provide differentiated services to carry connections with both reliability guarantee and resource optimization.

Room 304A-B

OWH • Multimode Fiber Applications—Continued

bution to the Working Group on Modal Bandwidth of Multimode Fibers and the development of U.S. standards for Fiber Optic Technology.

Dr. Pepeljugoski is an author or a coauthor of more than 40 journal or conference articles,,and is a senior member of IEEE.

OWH2 • 2:30 p.m.
Ultra-Compact, 0.5-Tb/s Parallel-WDM Optical Interconnect, *George Panotopoulos, Mohammed E. Ali, Edwin de Groot, Graham M. Flower, Glenn H. Rankin, Andrew J. Schmit, Kostadin D. Djordjev, Michael R. Tan, Ashish Tandon, William Gong, Richard P. Tella, Benjamin Law, David W. Dolfi, Brian E. Lemoff; Agilent Labs, USA.* We discuss a 12-fiber x 4-wavelength x 10.4-Gb/s short-distance parallel-wavelength-division-multiplexed optical interconnect. The 0.5-Tb/s transmitter and receiver assemblies each have a 5 x 8-mm footprint and together consume 2.95 W.

Notes

Ballroom A

OWA • Ultra Long-Haul Transmission—Continued

OWA5 • 2:45 p.m.
Effects of MPI Noise on Various Modulation Formats in Distributed Raman Amplified System, *Sang Bae Jun, Eui Seung Son, Hyun Young Choi, Kwan Hee Han, Yun Chur Chung; KAIST, Republic of Korea.* We evaluated the effect of MPI noise on various modulation formats in a distributed Raman amplified system. The results show that RZ-DPSK is the most tolerant modulation format to MPI noise.

OWA6 • 3:00 p.m.
Over 1000 Channel, 6.25 GHz-Spaced Ultra-DWDM Transmission with Supercontinuum Multi-Carrier Source, *Takuya Ohara, Hidehiko Takara, Takashi Yamamoto, Hiroji Masuda, Toshio Morioka, Makoto Abe, Hiroshi Takahashi; NTT Corp., Japan.* Over 1000 channel, 6.25 GHz spaced ultra-DWDM transmission is achieved using a supercontinuum multi-carrier source. We also investigate the influence of four-wave-mixing that occurred in the ultra-DWDM transmission.

OWA7 • 3:15 p.m.
Signal-Phase Diffusion by Fiber-Based All-Optical 2R Regenerators, *Masayuki Matsumoto; Osaka Univ., Japan.* Preservation of phase information on the signal by different types of fiber-based all-optical 2R regenerators is numerically studied. A FWM-based regenerator well preserves the phase and is suitable for amplitude regeneration of RZ-DPSK signals.

Ballroom B

OWB • Systems and Applications—Continued

OWB6 • 3:00 p.m.
Demonstration of an In-Band Auxiliary Channel for Path Trace in Photonic Networks, *Mark D. Feuer, Vinay A. Vaishampayan; AT&T Labs – Res., USA.* We demonstrate a new method for encoding path trace labels, or other management information, into WDM lightpaths in a network. Management data is extracted successfully using low-speed receivers without wavelength filters over the necessary wide range of optical signal-to-noise ratio.

OWB7 • 3:15 p.m.
Labeling of 40 Gbit/s DPSK Payload Using In-Band Subcarrier Multiplexing, *Thomas Flarup[1], Christophe Peucheret[1], Juan Jose Vegas Olmos[2], Yan Geng[1], Jianfeng Zhang[1], Idelfonso Tafur Monroy[2], Palle Jeppesen[1]; [1]Res. Ctr. COM, Denmark, [2]COBRA Res. Inst., Netherlands.* The transmission feasibility of 40 Gbit/s DPSK payload with in-band SCM labeling at 3 GHz subcarrier frequency is experimentally verified over 80 km NZDSF.

Ballroom C

OWC • Optical Burst Switching—Continued

OWC5 • 2:45 p.m.
End-to-End Layer-3 (IP) Packet Throughput and Latency Performance Measurements in an All-Optical Label Switched Network with Dynamic Forwarding, *Suresh Rangarajan[1], Henrik N. Poulsen[1], Paul G. Donner[2], Russell Gyurek[2], Vikrant Lal[1], Milan L. Masanovic[1], Daniel L. Blumenthal[1]; [1]Univ. of California at Santa Barbara, USA, [2]Cisco Systems Inc., USA.* We experimentally demonstrate dynamic IP-packet forwarding through an All-Optical Label-Swapped network and report true end-to-end Layer-3 IP throughput and latency performance measurements. Insignificant core throughput penalty and 0.79usecs latency increase were measured for 40 to 1500byte packets at OC-48 rates.

OWC6 • 3:00 p.m.
Dynamic Routing with Preplanned Congestion Avoidance for Survivable Optical Burst-Switched (OBS) Networks, *Yurong (Grace) Huang, Jonathan P. Heritage, Biswanath Mukherjee; Univ. of California at Davis, USA.* We develop dynamic routing mechanisms for preplanned congestion avoidance in OBS networks. Based on our routing mechanisms, we propose a new protection approach against failures which significantly improves network throughput and survivability.

OWC7 • 3:15 p.m.
Impact of Modulation Formats and SOA Chirp on the Throughput of SOA Based OBS Nodes, *Hao Buchta, Erwin Patzak; Fraunhofer Inst. for Telecommunications, Heinrich-Hertz-Inst., Germany.* NRZ- and RZ-modulation formats are compared with respect to throughput limitations for OBS nodes by using different SOA types. The impact of SOA chirp on dispersion compensation characteristic of the fiber link is also included.

Ballroom D

OWD • Nano-Photonics—Continued

OWD5 • 3:00 p.m.
Pulse Compression in Line Defect Photonic Crystal Waveguide, *Aimin Xing, Marcelo Darvanco, Stefano Camatel, Daniel J. Blumenthal, Evelyn L. Hu; Univ. of California at Santa Barbara, USA.* Dispersion properties of membrane-type line-defect Photonic Crystal waveguide were investigated using short optical pulses. Group velocity dispersion larger than 10ps/(mm*nm) were measured and pulse compression of approximately 60% was demonstrated.

OWD6 • 3:15 p.m.
Optimized Planar Photonic Crystal Waveguide 60° Bend with More than 200nm Wide 1-dB Transmission Bandwidth, *Martin Kristensen[1], Peter I. Borel[1], Lars H. Frandsen[1], Anders Harpoth[1], Jakob S. Jensen[2], Ole Sigmund[2]; [1]Res. Ctr. COM, Denmark, [2]Dept. of Mechanical Engineering, Denmark.* Topology optimization was used to design a planar photonic crystal waveguide 60° bend leading to a record-breaking transmission bandwidth of more than 200nm. The experimental results agree well with 3-D finite-difference-time-domain simulations.

Notes

3:30 p.m.–4:00 p.m. BEVERAGE BREAK, EXHIBIT HALL

Ballroom E

OWE • Modulators—Continued

OWE5 • 2:45 p.m.
An Empirical Model for High Yield Manufacturing of 10Gb/s Negative Chirp InP Mach-Zehnder Modulators, *Ian B. Betty[1], Marcel G. Boudreau[1], Robert A. Griffin[2], Andre Feckes[1]; [1]Bookham, Canada, [2]Bookham, UK.* A statistically valid empirical model is used to optimize InP Mach-Zehnder modulators to achieve high yield, wide tunability, record low insertion loss, and dispersion-Ltd. reach superior to that of -0.7α $LiNbO_3$ modulators.

OWE6 • 3:00 p.m.
Novel Segmented Cascade Electroabsorption Modulator with Improved Bandwidth-Extinction Product, *Jonathan T. Getty, Leif A. Johansson, Larry A. Coldren; Univ. of California at Santa Barbara, USA.* A new configuration for electroabsorption modulators is presented and demonstrated. Compared to a conventional device of the same length, a three-stage cascaded modulator nearly triples the RC-bandwidth while maintaining the same extinction and insertion loss.

OWE7 • 3:15 p.m.
Chirp-Controlled EA-Modulator/SOA/ Widely-Tunable Laser Transmitter, *Ping-Chiek Koh, Yuliya A. Akulova, Greg A. Fish; Agility Communications Inc., USA.* We report on chirp-controlled optical modulation realized using a semiconductor optical amplifier and an electroabsorption modulator monolithically integrated with a widely-tunable laser. The chirp parameter can be adjusted from +1.0 to -0.7 across 30 nm tuning range.

Room 303A-B

OWF • Amplifier Materials—Continued

OWF5 • 2:45 p.m.
A Single-Mode Tm-Doped Double-Clad Optical Fiber Amplifier Operating at 843 nm Wavelength, *Pramod R. Watekar, Seongmin Ju, Won-Taek Han; Gwangju Inst. of Science and Technology, Republic of Korea.* We report a novel single-mode Tm-doped amplifier optimized for first-window optical communication wavelength band. A peak gain of about 22.5 dB at 843 nm and the full-width-half-maximum wavelength band of about 20 nm has been obtained.

OWF6 • 3:00 p.m. Invited
Recent Progress in Bi-EDF Technologies, *Naoki Sugimoto; Asahi Glass Co., Japan.* Bismuth based erbium doped fiber exhibits inherent features which cannot be realized with silica based EDF. Extend L-band amplification, high gain C+L band amplification for coarse WDM and short pulse amplification are reported.

Room 303C-D

OWG • Network Design I—Continued

OWG6 • 2:45 p.m.
Re-Optimization Strategies to Maximize Traffic-Carrying Readiness in WDM Survivable Mesh Networks, *Dion Leung[1], Shin'ichi Arakawa[2], Masayuki Murata[3], Wayne D. Grover[1]; [1]TRLabs, Univ. of Alberta, Canada, [2]Graduate School of Economics, Osaka Univ., Japan, [3]Cybermedia Ctr., Osaka Univ., Japan.* We propose and compare four re-optimization strategies for mesh survivable networks. We show how these strategies improve the network's ability to carry future random-arrival traffic.

OWG7 • 3:00 p.m. Invited
The OptIPuter, Quartzite and Starlight Projects: A Campus to Global-Scale Testbed for Optical Technologies Enabling LambdaGrid Computing, *Larry Smarr[1], Joe Ford[1], Phil Papadopoulos[1], Shaya Fainma[1], Thomas DeFanti[2], Maxine Brown[2], Jason Leigh[2]; [1]Univ. of California at San Diego, USA, [2]Univ. of Illinois at Chicago, USA.* Dedicated optical connections have significant advantages over shared internet connections. The OptIPuter project (www.optiputer.net) uses medical and earth sciences imaging as application drivers. Quartzite (UCSD) and Starlight (Chicago) create unique combinations of OEO routers and OOO and wavelength-selective optical switches.

Room 304A-B

OWH • Multimode Fiber Applications—Continued

OWH3 • 2:45 p.m.
1-km Transmission of 10 Gbit/s Optical Signal over Legacy MMF Using Mode Limiting Transmission and Incoherent Light Source, *Toshihiro Itoh[1], Hiroyuki Fukuyama[1], Satoshi Tsunashima[1], Eiji Yoshida[2], Yoshiaki Yamabayashi[2], Masahiro Muraguchi[1], Hiromu Toba[1], Hirohiko Sugahara[1]; [1]NTT Photonics Labs, NTT Corp., Japan, [2]NTT Electronics Corp., Japan.* 10 Gbit/s optical signals were transmitted through legacy multimode fibers (MMFs) by using mode limiting and incoherent light sources. Stable transmission through a 1-km-long MMF was realized by inserting a singlemode fiber (SMF) at midpoint.

OWH4 • 3:00 p.m. Invited
Parallel-Optical Interconnects and Their Applications, *Lisa Buckman Windover; Agilent Technologies, USA.* Research and development on parallel-optical interconnects has continued for over a decade. A review will be given of the applications of parallel optics, existing 12x2.5-Gb/s parallel optics, recent 12x10-Gb/s parallel optics, and next-generation optical interconnects.

Notes

3:30 p.m.–4:00 p.m. BEVERAGE BREAK, EXHIBIT HALL

Ballroom A

4:00 p.m.–5:45 p.m.
OWI • Quantum Communications
TBA; Presider

OWI1 • 4:00 p.m. Tutorial
Quantum Key Distribution—The Science of Secret Communication, *Richard Hughes; Los Alamos Natl. Lab, USA.* Quantum key distribution (QKD) uses single photon communications to securely transfer cryptographic keys that are required for secure communications. I will describe the theory of QKD and its implementation in both optical fiber and free-space.

Richard J. Hughes is a Laboratory Fellow in the Physics Division at Los Alamos National Laboratory. He is principal investigator of projects in both free-space and optical fiber based quantum key distribution. He became a Fellow of the American Physical Society in 1999. In 2001 he was co-winner of an R&D100 Award for "Free-space quantum cryptography." He chairs the Advanced Research and Development Activity's Quantum Information Science and Technology roadmap. Hughes has authored over 120 scientific papers on quantum field theory, the foundations of quantum mechanics, quantum cryptography and quantum computation.

Ballroom B

4:00 p.m.–5:30 p.m.
OWJ • Optical Signal Measurements
Kim Roberts; Nortel Networks, Canada, Presider

OWJ1 • 4:00 p.m.
Optical Noise Estimation Using Direct Measurement of Constellation Diagrams by Linear Optical Sampling, *Christophe Dorrer; Bell Labs, Lucent Technologies, USA.* Constellation diagrams of the electric field of optical sources are directly measured using linear optical sampling. The noise induced by the data modulator, amplified spontaneous emission and nonlinear propagation (i.e. Gordon-Mollenauer effect) are accurately characterized.

OWJ2 • 4:15 p.m.
Optical Channel Performance Monitoring Using Coherent Detection, *Biao Fu, Rongqing Hui; EECS Dept., Univ. of Kansas, USA.* We demonstrate a multi-functional optical system performance monitor using coherent heterodyne detection. In addition to performing high-resolution optical spectrum analyzing, the system is capable of monitoring chromatic dispersion and PMD at each wavelength channel.

OWJ3 • 4:30 p.m.
Fiber-Based All-Optical Sampling System with Simultaneous -17 dBm Sensitivity, 1 ps Temporal Resolution and 60 nm Optical Bandwidth, *Mathias Westlund, Henrik Sunnerud, Peter A. Andrekson; Chalmers Univ. of Technology, Dept. of Microtechnology and Nanoscience, Photonic Lab, Sweden.* We demonstrate a fiber four-wave mixing based all-optical sampling system with simultaneous -17 dBm sensitivity, 1 ps temporal resolution and 60 nm optical bandwidth.

Ballroom C

4:00 p.m.–6:00 p.m.
OWK • Optical Packet Switching
Chunming Qiao; SUNY, USA, Presider

OWK1 • 4:00 p.m.
Demonstration of a Complete 12-Port Terabit Capacity Optical Packet Switching Fabric, *Benjamin A. Small, Odile Liboiron-Ladouceur, Assaf Shacham, John P. Mack, Keren Bergman; Columbia Univ., USA.* We report on the implementation of a complete 12-port Data Vortex optical packet switching fabric containing 36 fully-interconnected nodes. Correct routing behavior is verified for 14-channel WDM packets, and latencies below 60 ns are achieved.

OWK2 • 4:15 p.m.
Demonstration of User-Controlled Network Interface for Sub-Wavelength Bandwidth-on-Demand Services, *Reza Nejabati, Dimitris Klonidis, Dimitra Simeonidou, Mike O'Mahony; Univ. of Essex, UK.* This paper presents hardware architecture for a user-controlled network interface supporting sub-wavelength bandwidth-on-demand services. Results show the architecture is well suited for mapping user traffic into optical packets or bursts directly controlled by the user.

OWK3 • 4:30 p.m.
Performance of DPSK and NRZ-OOK Signals in a Novel Folded-Path Optical Packet Switch Buffer, *Yong-Kee Yeo, Jianjun Yu, Gee-Kung Chang; Georgia Tech, USA.* A novel and physically compact optical time delay buffer with nanoseconds reconfigurability is presented. Experiment results showed that the optimization of various design parameters resulted in greater range of delay value and smaller delay time step granularity.

Ballroom D

4:00 p.m.–6:00 p.m.
OWL • Microstructured Fibers
John M. Fini; OFS Labs, USA, Presider

OWL1 • 4:00 p.m.
New High Bandwidth Single Polarization Fiber with Elliptical Central Air Hole, *Ming-Jun Li, Xin Chen, Daniel A. Nolan, George E. Berkey, Ji Wang, William A. Wood, Luis A. Zenteno; Corning Inc., USA.* A new single polarization fiber with an elliptical central air hole is proposed. Effects of fiber design parameters on fiber performance are analyzed. Single polarization bandwidth as high as 240 nm is predicted.

OWL2 • 4:15 p.m.
Characteristics and Application of 50 μm Cladding Optical Fibers, *Upendra H. Manyam, Kanishka Tankala, Julia Farroni, Doug Guertin, Jean Aldrich, Jaroslaw Abrmczyk, Nils Jacobson; Nufern, USA.* Optical fibers of 50 μm cladding diameter are fabricated and characterized for optical and mechanical performance. The results indicate that through proper design, they can be made suitable for integration into optical components and devices.

OWL3 • 4:30 p.m. Invited
Fabrication of Dispersion Controlled and Polarization Maintaining Photonic Crystal Fiber for High Performance Systems and Devices, *Masatoshi Tanaka[1], Satoki Kawanishi[2]; [1]Mitsubishi Cable Industries Ltd., Japan, [2]Nippon Telegraph and Telephone Corp., Japan.* This paper reports on the characteristics of the polarization maintaining photonic crystal fiber and shows that it is at a level of practical use. We also discuss the dispersion-flattened photonic crystal fiber designed for nonlinear optics application.

Notes

Ballroom E

4:00 p.m.–5:30 p.m.
OWM • Quantum Dot Lasers
Kristian Stubkjaer; Technical Univ. of Denmark, Denmark, Presider

OWM1 • 4:00 p.m. Invited
Quantum Dots for Lasers, Amplifiers and Photonic Systems, *Dieter H. Bimberg; Technical Univ. Berlin, Germany.* Self-organisation on surfaces of semiconductors was discovered by us to lead to the formation of quantum dots. QD-based edge and surface emitting lasers and amplifiers are superior to classical QW-lasers.

OWM2 • 4:30 p.m. Invited
Quantum Dots for Semiconductor Optical Amplifiers, *Tomoyuki Akiyama[1,2], M. Ekawa[1,2], M. Sugawara[3], K. Kawaguchi[1,2], H. Sudo[1,2], H. Kuwatsuka[1,2], H. Ebe[3], A. Kuramata[2,3], Y. Arakawa[3]; [1]Fujitsu Labs Ltd., Japan, [2]OITDA, Japan, [3]Univ. of Tokyo, Japan.* This paper reviews the recent progress of quantum-dot semiconductor optical amplifiers, especially highlighting the properties of ultrawide band, high power, and low distortion, and signal regeneration at 40 Gb/s newly achieved in the 1.5 μm band.

Room 303A-B

4:00 p.m.–6:00 p.m.
OWN • Parametric Amplifiers
Prem Kumar; Northwestern Univ, USA, Presider

OWN1 • 4:00 p.m.
Quantum Noise Properties of Parametric Devices Driven by Two Pump Waves, *Colin J. McKinstrie[1], Stojan Radic[2], Michael G. Raymer[3]; [1]Lucent Technologies, USA, [2]Univ. of California at San Diego, USA, [3]Univ. of Oregon, USA.* In parametric amplifiers and frequency-convertors driven by two pump waves, each signal sideband is coupled to three idler sidebands. Formulas are derived for the signal and idler noise-figures of these devices.

OWN2 • 4:15 p.m.
Multiple Wavelength Conversion with Gain by High Repetition-Rate Pulsed-Pump Fiber OPA, *Georgios Kalogerakis, Michel E. Marhic, Leonid G. Kazovsky; Stanford Univ., USA.* We propose and demonstrate a novel multiple wavelength converter with gain based on a pulsed-pump fiber optical parametric device. Penalties ranging from 0.26 to 1.24 dB for $\pm k$x100 GHz (k=1,2,3,4) wavelength conversion were measured.

OWN3 • 4:30 p.m.
Impact of Pump-Phase Modulation on the Performance of Dual-Pump Fiber-Optic Parametric Amplifiers, *Fatih Yaman[1], Qiang Lin[1], Stojan Radic[2], Govind P. Agrawal[1]; [1]Inst. of Optics, USA, [2]Univ. of California at San Diego, USA.* We show that modulation of pump phases in dual-pump fiber-optic parametric amplifiers produce large signal fluctuations because of fiber dispersion. The performance becomes worse when phase is modulated using pseudorandom bit patterns with a sharp rise time.

Room 303C-D

4:00 p.m.–6:00 p.m.
OWO • PMD and CD Compensation
David Weidman; Avanex, USA, Presider

OWO1 • 4:00 p.m. Invited
Deploying Optical PMD Compensators, *Harald Rosenfeldt; Adaptif PHOTONICS, Germany.* Adaptive compensators are considered as attractive way to overcome limitations caused by PMD in 40G systems and beyond. However, numerous problems still prevent this technology from being deployed in commercial systems. This paper gives an overview over existing solutions.

OWO2 • 4:30 p.m.
SiGe Equalizer IC for PMD Mitigation and Signal Optimization of 40Gbit/s Transmission, *Ross Saunders, Hong Jiang, Stephen Colaco; StrataLight Communications, USA.* A SiGe equalizer IC has been developed to mitigate fiber-induced and electro-optical distortions for 40Gbits/s optical transmission. Experiments show 50% improvement in 1st-order PMD tolerance for 1dBQ penalty and 1dB improvement in back-to-back OSNR sensitivity.

Room 304A-B

4:00 p.m.–6:00 p.m.
OWP • FTTX
David Piehler; Harmonic Inc., USA, Presider

OWP1 • 4:00 p.m.
Increasing FTTH Reliability between Premise and Indoor Lines, *Itsuo Kuramoto[1], Yasushi Terao[1], Hiroyasu Honda[1], Katsushi Nakayachi[2]; [1]NTT-NEOMEIT, Japan, [2]NTT, Japan.* An analysis of faults subsequent to service starting on premise and indoor FTTH lines, with countermeasures were implemented. As a result, the reliability of FTTH is getting nearly the same as for metal lines.

OWP2 • 4:15 p.m.
Reducing Costs for First One Mile FTTH Lines, *Hiroyuki Hayashida[1], Mitsunori Yasunaga[1], Kenichi Nakazawa[2], Yasuhiko Hoshino[1], Tsunetaka Ema[2], Hiroshi Tanaka[3], Yasuo Oda[3]; [1]NTT-NEOMEIT, Japan, [2]NTT-WEST, Japan, [3]NTT, Japan.* A variety of strategies have been implemented to bring installation costs to near metallic wire levels, in consideration of suiting the layout of house and efficiency for FTTH drop and indoor lines.

OWP3 • 4:30 p.m. Invited
Passive Optical Networks for FTTx Applications, *Chang-Hee Lee; KAIST, Republic of Korea.* Applications of passive optical networks, especially WDM-PON, for FTTH and FTTPole are investigated. We also demonstrate a new WDM-PON based on wavelength locked FP-LDs to injected spectrum sliced narrow band ASE.

Exhibit Hall D

Market Watch
4:00 p.m.–6:00 p.m.
Out of the Gloom—One Year Later: Optical Renaissance or False Hopes?

Moderator: *Stagg Newman, Senior Practice Expert, McKinsey and Co., USA*

Speakers:

- *Drew Lanza, General Partner, Morgenthaler Ventures, USA*
- *Brant Thompson, Vice President, Communications Technology Group, Goldman Sachs & Co., USA*
- *Daniel Docter, Senior Investment Manager, Intel Capital, USA*
- *Jeff Evenson, Vice President and Senior Analyst, Sanford C. Bernstein & Co., LLC, USA*

(See page 12 for details.)

Ballroom A

OWI • Quantum Communications—Continued

OWI2 • 5:00 p.m.
Demonstration of 1.3 μm Quantum Key Distribution (QKD) Compatibility with 1.5 μm Metropolitan Wavelength Division Multiplexed (WDM) Systems, *Robert J. Runser[1], Thomas E. Chapuran[1], Paul Toliver[1], Matthew S. Goodman[1], Janet Jackel[1], Nnake Nweke[2], Scott R. McNown[2], Richard J. Hughes[3], Charles G. Peterson[3], Kevin McCabe[3], Jane E. Nordholt[3], Kush Tyagi[3], Philip Hiskett[3], Nicholas Dallmann[3]; [1]Telcordia Technologies, USA, [2]Lab for Telecommunication Sciences, USA, [3]Los Alamos Natl. Lab, USA.* Impairment-free multiplexing and transmission of a 1.3 μm QKD system with a multi-wavelength 1.5 μm metropolitan area DWDM system is demonstrated with a quantum BER of 4.6% over 25 km of standard singlemode fiber.

Ballroom B

OWJ • Optical Signal Measurements—Continued

OWJ4 • 4:45 p.m.
A Novel Technique for Modulation Alignment Monitoring in RZ-DPSK Systems Using Off-Center Optical Filtering, *Yuen-Ching Ku, Guo-Wei Lu, Chun-Kit Chan, Lian-Kuan Chen; The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* A novel high-speed polarization-independent off-center optical filtering technique for monitoring alignment status between pulse generator and data modulator in RZ-DPSK systems is proposed and demonstrated. A monitoring dynamic range of 3.35 dB is achieved experimentally.

OWJ5 • 5:00 p.m.
Electrical Estimation of Conditional Probability for Maximum-Likelihood Based PMD Mitigation, *Wenze Xi, Tulay Adali, John Zweck; Univ. of Maryland, Baltimore County, USA.* Accurate probability density functions in the presence of both all-order PMD and ASE noise are estimated electronically, and used for maximum likelihood sequence estimation and a maximum a posteriori detection to mitigate PMD in the presence of ASE noise.

Ballroom C

OWK • Optical Packet Switching—Continued

OWK4 • 4:45 p.m.
Programmable Optical Buffering Using Fiber Bragg Gratings Combined with a Widely-Tunable Wavelength Converter, *Chin-Hui Chen, Leif A. Johansson, Vikrant Lal, Milan L. Mašanović, Danial J. Blumenthal, Larry A. Coldren; Univ. of California at Santa Barbara, USA.* A 40Gbps RZ all-optical buffering method implemented by FBG and tunable wavelength converter is presented. Preliminary results of time-delay up to 7μs and pulse broadening were measured. System measurements at 10Gbps show desired delay programmability.

OWK5 • 5:00 p.m.
Self-Configuring Intelligent Control for Short Reach 100Gb/s Optical Packet Routing, *Tao Lin[1], Kevin A. Williams[1], Madeleine Glick[2], Richard V. Penty[1], Ian H. White[1], Derek McAuley[2]; [1]Univ. of Cambridge, UK, [2]Intel Res. Cambridge, UK.* An advanced control architecture is proposed which recognizes and configures new connections, automatically performs calibration and initiates the routing of 100Gb/s data packets. The scheme is proposed for high capacity, low overhead, short reach networking.

Ballroom D

OWL • Microstructured Fibers—Continued

OWL4 • 5:00 p.m.
Improving Bending Losses in Holey Fibers, *Joanne C. Baggett, Tanya M. Monro, John R. Hayes, Vittoria Finazzi, David J. Richardson; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* Preliminary work has shown that the bending losses of large-mode-area holey fibers can be improved by modifying the hole configuration [1]. For the first time, we accurately quantify the advantages of this technique.

Notes

Ballroom E

OWM • Quantum Dot Lasers—Continued

OWM3 • 5:00 p.m.
1.5 μm InGaAs/InGaAsP/InP Quantum Dot Lasers Operating cw at Room Temeprature, *Weon G. Jeong[1], Heedae Kim[1], D. Lee[2], P. D. Dapkus[3], R. Stevenson[3], M. S. Hwang[2], J. W. Jang[4], S. H. Pyun[4]; [1]Sungkyunkwan Univ., Republic of Korea, [2]Chungnam Univ., Republic of Korea, [3]Univ. of Southern California, USA, [4]NanoEpi Technologies Corp., Republic of Korea.* Cw operation of QD lasers emitting at ~1.5 μm at room temperature have been demonstrated. J_{th} per QD stack of ~430 A/cm^2 is measured for broad area lases with 5, 7, and 10 QD stacks.

Room 303A-B

OWN • Parametric Amplifiers—Continued

OWN4 • 4:45 p.m.
Q Penalties Due to Pump Phase Modulation in FOPAs, *Jose M. Chavez Boggio, Fulvio A. Callegari, André Guimarães, Jorge D. Marconi, Hugo L. Fragnito; Optics and Photonics Res. Ctr., Brazil.* We investigate Q penalties in FOPAs arising from variations of the parametric gain originated by pump phase modulation. We show that these penalties are strongly reduced in fibers with large variations of the zero dispersion wavelength (λ_0).

OWN5 • 5:00 p.m.
Stimulated-Brillouin-Scattering Suppression Using a Single Modulator in Two-Pump Parametric Architectures, *S. Radic[1], R. M. Jopson[2], A. Gnauck[2], C. J. McKinstrie[2], J. C. Centanni[2], A. R. Chraplyvy[2]; [1]Dept. of Electrical and Computer Engineering, Univ. of California at San Diego, USA, [2]Bell Labs, Lucent Technologies, USA.* We achieve synchronous phase modulation in a two-pump parametric processor using one phase modulator to provide stimulated Brillouin scattering suppression to both pumps. Simple frequency tuning controls the pump synchronization.

Room 303C-D

OWO • PMD and CD Compensation—Continued

OWO3 • 4:45 p.m.
A Highly Efficient and Selective Spatial Mode Transformer for High-Order-Mode Dispersion Compensation Modules, *Yonathan Japha[1,2], Udi Ben-Ami[1], Eran Herman[1], Uri Levy[1], David Menashe[1], Yochay Danziger[1], Moshe Tur[1,3]; [1]LaserComm Inc., Israel, [2]Ben-Gurion Univ. of the Negev, Israel, [3]Tel-Aviv Univ., Israel.* A method to implement highly efficient and selective transformation between different fiber modes is presented. It is based on free space wavefront manipulation and enables the construction of high performance high-order mode dispersion compensating modules.

OWO4 • 5:00 p.m. Invited
Automatic Control of Optical Equalizers, *Marc Bohn[1], Peter M. Krummrich[1], Werner Rosenkranz[2], Folkert Horst[3], Bert J. Offrein[3], Gian L. Bona[3]; [1]Siemens AG, Germany, [2]Chair for Communications, Univ. of Kiel, Germany, [3]IBM Zurich Lab, Switzerland.* Optical equalizers for an adaptive compensation of varying distortions in high-bitrate optical transmission systems are currently of high interest. In this paper we review strategies for an automatic control of optical equalizers.

Room 304A-B

OWP • FTTX—Continued

OWP4 • 5:00 p.m.
RF/IP Hybrid Network for Video Delivery over FTTP, *Curtis Knittle, Gaurav Rishi, David Pichler; Harmonic Inc., USA.* The two video architectures for an FTTP network are CATV-like RF video, and switched digital video. The optimal architecture is a hybrid, using the RF for broadcast video and switched IP for targeted video.

Notes

Ballroom A

OWI • Quantum Communications—Continued

OWI3 • 5:15 p.m.
Quantum Generated One-Time-Pad Encryption with 1.25 Gbps Clock Synchronization, *Joshua C. Bienfang[1], Alan Mink[1], Barry J. Hershman[1], Tassos Nakassis[1], Xiao Tang[1], Ron F. Boisvert[1], Davi H. Su[1], Charles W. Clark[1], Carl J. Williams[1], Alex J. Gross[2], Edward W. Hagley[2], Jesse Wen[2]; [1]NIST, USA, [2]Acadia Optronics, USA.* Clock recovery techniques at 1.25 Gbps enable quantum key distribution at sifted-key rates greater than 3.5 Mbps. Our system incorporates expeditious forward error correction algorithms, and is designed for practical implementation of the one-time-pad cipher.

OWI4 • 5:30 p.m.
High-Speed QKD System Synchronized by Automatic Phase-Alignment Mechanism, *Wakako Maeda, Akio Tajima, Akihiro Tanaka, Seigo Takahashi, Tsuyoshi Takeuchi; NEC Corp., Japan.* A high-speed QKD system, which has an automatic modulation-phase-alignment mechanism for compensating for GVD, was developed. Using this system, we confirmed high-speed and stable quantum key distribution with transmissions over 40 km was possible.

Ballroom B

OWJ • Optical Signal Measurements—Continued

OWJ6 • 5:15 p.m.
Optical Sampling System Including Clock Recovery for 320 Gbit/s DPSK and OOK Data Signals, *Carsten Schmidt-Langhorst, Colja Schubert, Christof Boerner, Vincent Marembert, Sebastian Ferber, Reinhold Ludwig, Hans-Georg Weber; Fraunhofer Inst. for Telecommunications, Heinrich-Hertz-Inst., Germany.* Measurements of eye diagrams of 320Gbit/s DPSK signals after 160km transmission are reported using an optical sampling system with clock recovery and 1.0ps resolution, which accepts amplitude or phase modulated data signals and allows measurements with large persistence time.

Ballroom C

OWK • Optical Packet Switching—Continued

OWK6 • 5:15 p.m.
Instantaneous Clock Recovery for Burst-Mode Optical Label and Payload by Using a Conventional Data Receiver, *Jianjun Yu, Gee Kung Chang; Georgia Tech, USA.* We have demonstrated a novel method using a conventional receiver to detect preamble free label and payload in burst-mode transmission in an optical label switched network. The extracted clock exhibits shows small jitter.

OWK7 • 5:30 p.m. Invited
Optical Networking beyond 40 Gbit/s, *Huug de Waardt, E. Tangdiongga, J.P. Turkiewicz, G.D. Khoe; COBRA InterUniv. Res. Inst., Netherlands.* 160 Gbit/s OTDM networks will need nodes with add-drop multiplexers to extract and insert channels at lower bitrates. We will review the current status of add-drop multiplexing for bit rates up to 160 Gbit/s and beyond.

Ballroom D

OWL • Microstructured Fibers—Continued

OWL5 • 5:15 p.m.
Single-Mode Operation in Silica-Core Bragg Fibers, *Takashi Katagiri, Yuji Matsuura, Mitsunobu Miyagi; Tohoku Univ., Japan.* Silica-core Bragg fibers with a diameter below 10 μm are fabricated by sputtering technique. Bandgap guidance over a broadband wavelength range and the mode profile which corresponds with HE11 mode are observed.

OWL6 • 5:30 p.m. Invited
Solgel-Derived Microstructured Fibers: Fabrication and Characterization, *Ryan T. Bise, Dennis Trevor; OFS Labs, USA.* We discuss a sol-gel casting technique for fabricating microstructured optical fiber. Both the advantages and challenges associated with this fabrication method are outlined.

Notes

Ballroom E

OWM • Quantum Dot Lasers—Continued

OWM4 • 5:15 p.m.
Low Timing Jitter, 5 GHz Optical Pulses from a Monolithic Two-Section Passively Mode-Locked 1250/1310 nm Quantum Dot Laser for High Speed Optical Interconnects, *Lei Zhang[1], Ling Shen Cheng[1], Allen L. Gray[1], Sanh Luong[1], John Nagyvary[1], Faisal Nabulsi[1], Leonard Olona[1], Kathy Sun[1], Tom Tumolillo[1], Ronghua Wang[1], Chris Wiggins[1], John Zilko[1], Zheng-Zhong Zou[1], Petros M. Varangis[1], Hui Su[2], Luke F. Lester[2]; [1]Zia Laser, Inc., USA, [2]Ctr. for High Technology Materials, Univ. of New Mexico, USA.* Sub-picosecond timing jitter is demonstrated for 5GHz, <10ps optical pulses generated from monolithic passively mode-locked quantum dot lasers. Their low cost, compact size and DC-biased operation make them ideal for high speed optical interconnects.

Room 303A-B

OWN • Parametric Amplifiers—Continued

OWN6 • 5:15 p.m.
Experimental Investigation of a Frequency-Nondegenerate Phase-Sensitive Optical Parametric Amplifier, *Renyong Tang, Preetpaul Devgan, Jacob Lasri, Vladimir Grigoryan, Prem Kumar; Ctr. for Photonic Communications and Computing, ECE Dept., Northwestern Univ., USA.* We demonstrate the first fiber-optic phase-sensitive parametric amplifier based on frequency-nondegenerate four-wave mixing. An input signal is phase-sensitively amplified and the measured gain response matches well with the theory.

OWN7 • 5:30 p.m.
Investigation of Electrical Noise Figure for Fiber Optical Parametric Amplifiers, *Anne Durécu-Legrand[1], Christian Simonneau[1], Dominique Bayart[1], Arnaud Mussot[2], Thibault Sylvestre[2], Eric Lantz[2], Hervé Maillotte[2]; [1]Alcatel R&I, France, [2]CNRS / Univ. de Franche-Comté, France.* Electrical measurements of the noise figure of a fiber optical parametric amplifier are presented and compared with optical measurements. The transfer of pump noise by Four-Wave Mixing was clearly demonstrated.

OWN8 • 5:45 p.m.
Raman Enhanced S-Band Fiber Optic Parametric Amplifier and S/C Band Wavelength Converter: Experiment and Simulations, *Joao F. Freitas, Stefan R. Lüthi, Anderson S. Gomes; UFPE, Brazil.* We demonstrate 9dB gain enhancement in S-band optical parametric amplification and 7dB net conversion efficiency enhancement and S/C band wavelength conversion by simultaneous Raman amplification using a highly nonlinear fiber. Numerical simulations support the experimental results.

Room 303C-D

OWO • PMD and CD Compensation—Continued

OWO5 • 5:30 p.m.
Polymer Fiber Bragg Gratings Tunable Dispersion Compensation, *Huiyong Liu; Univ. of New South Wales, Australia.* We propose a new scheme for tunable dispersion with large tuning range and a fixed center wavelength using linearly chirped polymer fiber Bragg gratings. Simple tension and uniform heating are employed as the control process.

OWO6 • 5:45 p.m.
Optically Tunable Dispersion Compensator Based on Coupled-Cavity Etalon Structure, *Xuewen Shu, Kate Sugden, Ian Bennion; Photonics Res. Group, Aston Univ., UK.* We demonstrate for the first time an optically tunable dispersion compensator, which is based on pumping a coupled-cavity etalon made in Er/Yb co-doped fiber. The dispersion was tuned from -300 to +400ps/nm in the experiment.

Room 304A-B

OWP • FTTX—Continued

OWP5 • 5:15 p.m.
Achieving Open Access in Ethernet PON (EPON), *Amitabha Banerjee[1], Biswanath Mukherjee[1], Glen Kramer[2]; [1]Univ. of California at Davis, USA, [2]Teknovus Inc., USA.* "Open access" is a regulatory requirement in many countries mandating that the residential access network infrastructure be competitively available to service providers. We propose Dual Service-Level Agreements (SLAs) to enforce fairness in open access EPON.

OWP6 • 5:30 p.m. Invited
Verizon's Fiber to The Premises Deployment: Lessons Learned, *Vincent O'Byrne; Verizon, USA.* To make FTTP a reality various architectural choices have to be made to make the deployment and its adoption by the customer cost effective. This paper reviews such decisions and lessons learned in Verizon's FTTP deployment.

Notes

6:00 p.m.–7:30 p.m.
JWA • Poster Session II

▶ Category A: Linear and Nonlinear Fibers

JWA1
Long Term PMD Characterization of Installed G.652 Fibers in a Metropolitan Network, *Silvio Abrate[1], Antonino Nespola[1], Pierluigi Poggiolini[2], Maurizio Magri[2]; [1]Inst. Superiore Mario Boella, Italy, [2]Politecnico di Torino, Italy.* We investigated the long-term PMD behavior of a metropolitan G.652 fiber plant of a major Italian telecom operator, installed in Turin, Italy. We found that the expected maxwellian distribution is not always achieved, as well as other statistical anomalies.

JWA2
Fast PMD and PDL Measurement of Aerial Fiber, *David S. Waddy[1], Liang Chen[2], Xiaoyi Bao[2]; [1]Waddy & Colpitts Ltd., Canada, [2]Univ. of Ottawa, Canada.* The fastest sampling of PMD of an aerial fiber is presented. Aerial fiber PDL is studied for this first time. PMD and PDL is shown to be loosely correlated. PMD is shown to change at a rate < 800 microseconds.

JWA3
Impact of Systematic External Birefringence on PMD, *Tommy Geisler, Poul Kristensen; OFS, Denmark.* By simulation it is shown that fibers with a small intrinsic polarization mode dispersion (PMD) may be compromised more than those with large PMD when subject to a source of deterministic extrinsic birefringence, e.g. stress.

JWA4
Comparison and Assessment of Different Polarization Mode Dispersion Models, *Chongjin Xie, Lothar Möller; Bell Labs, Lucent Technologies, USA.* We compare first-, second- and all-order PMD models for systems with and without first-order PMD compensation. Often the first- and second-order PMD models fail by overestimating PMD distortions, especially when the PMD is large.

JWA5
Next Generation Fiber Manufacturing for the Highest Performing Conventional Single Mode Fiber, *Kai H. Chang[1], Joseph P. Fletcher[1], John Rennell[1], Akio Nakajima[1], Jan Vydra[2], Ralph Sattmann[2]; [1]OFS, USA, [2]Heraeus Tenevo AG, Germany.* A low-cost, large preform (> 5000 fiber km) manufacturing process for the highest performing conventional single-mode fiber is described. Key manufacturing steps and fiber performance parameters are highlighted.

JWA6
Widely Tunable Sub-Picosecond Compression of 40 GHz Externally-Modulated Pulse Train Using 1.4 km Long Comb-Like Profiled Fiber, *Koji Igarashi, Hideaki Tobioka, Masanori Takahashi, Jiro Hiroishi, Takeshi Yagi, Misao Sakano, Shu Namiki; Furukawa Electric Co., Ltd., Japan.* We demonstrated the compression to 500 fs of 40 GHz externally-modulated pulse train with a wideband tunablity over 1530 - 1560 nm. A comb-like profiled fiber plays an important role in the widely tunable operation.

JWA7
Design of Comb-like Profiled Fiber for Efficient Pulse Compression Based on Stationary Rescaled-Pulse Propagation, *Takashi Inoue, Hideaki Tobioka, Koji Igarashi, Shu Namiki; Furukawa Electric Co., Ltd., Japan.* We propose a design procedure of comb-like profiled fiber compressor based on stationary rescaled-pulse propagation, and demonstrate optical pulse compression of 7-ps pulse train to 375-fs through the designed compressor with only four steps.

JWA8
Accurate Raman Gain Measurement of Field Deployed Optical Fiber Cables with Small Pumping Power, *Takayuki Miyakawa[1], Yasuyuki Nagao[1], Masakazu Nakada[2]; [1]KDDI R&D Labs Inc., Japan, [2]KDDI Corp., Japan.* We have succeeded in measuring Raman gain of field deployed optical cables accurately with an average pumping power of only about 25mW. We assessed the fiber/cable dependency and the ambient temperature dependency of the Raman gain for forty fibers.

JWA9
Polarization Insensitive Four-Wave Mixing Assisted by Raman Amplification: Influence of Raman-Induced Kerr Effect, *Zhaohui Li[1], Fuyun Lu[2], Xiao Hann Lim[1], Yixin Wang[1], Xiaoqun Zhou[1], Chao Lu[1]; [1]Lightwave Dept., Inst. for Infocomm Res., Singapore, [2]Inst. of Physics, Nankai Univ., China.* The polarization degree of the two wavelengths involved in FWM can be decreased in the resonant spectra of stimulated Raman scattering, leading to polarization insensitive FWM being observed by using a continuous wave pump source.

▶ Category B: Amplifiers

JWA10
Pump-to-Signal FWM of Co-Pumped Raman Amplifier for Remote Pumps Supervisory, *Zhaohui Li[1], Fuyun Lu[2], Zhihong Li[1], Xiao Hann Lim[1], Chao Lu[1]; [1]Inst. for Infocomm Res. (I2R), Singapore, [2]Inst. of Physics, Nankai Univ., China.* A novel remote pumps monitoring scheme based on pump-to-signal four-wave mixing in a 50m highly nonlinear dispersion shifted photonic crystal fiber is proposed in this paper.

JWA11
Er:Yb-doped Waveguide Amplifier and Laser Fabricated by Using a New Diode-Pumped Femtosecond Oscillator, *Giuseppe Della Valle[1], Stefano Taccheo[1], Roberto Osellame[1], Giulio Cerullo[1], Nicola Chiodo[1], Paolo Laporta[1], O. Svelto[1], Alexander Killi[2], Uwe Morgner[2], Max Lederer[3], Daniel Kopf[3]; [1]INFM-Politecnico di Milano & IFN-CNR, Italy, [2]Max-Planck-Inst. für Kernphysik, Germany, [3]HighQLaser Production GmbH, Germany.* We demonstrated effective amplification and laser action in a 20-mm-long waveguide fabricated on a erbium-ytterbium-doped phosphate-glass by new diode-pumped femtosecond laser pulses. Gain in the full C-band with >2-dB/m peak value and laser action with 2-dBm output power was achieved.

JWA12
Experimental Study on Crosstalk in Double-Pumped Fiber Optic Parametric Amplifier, *Fulvio A. Callegari, Jose M. Chávez Boggio, Jorge D. Marconi, André Guimarães, Hugo L. Fragnito; Optics and Photonics Res. Ctr., Brazil.* The performance of five WDM modulated channels amplified with a double-pumped fiber optic parametric amplifier is experimentally analysed. We observe that crosstalk between channels diminishes when the amplifier is designed with a shorter fiber.

JWA13
Dual-Wavelength Pumped TDFAs for S-Band Optical Telecommunication: An Evaluation, *Anderson S. Gomes, Stefan R. Lüthi; UFPE, Brazil.* Different dual-wavelength pumping schemes for TDFAs are characterized and evaluated for their feasibility in S-band optical telecommunications networks. The main focus is on systems impairments due to transient effects, gain cross saturation and bit error rate.

JWA14
A Technique for the Measurement of the Residual Birefringence in Erbium-Doped Fibers, *Diana Tentori[1], Cesar Ayala[1], Javier Mendieta[1], Miguel Farfan[1], Fernando Treviño[2]; [1]CICESE Res. Ctr., Mexico, [2]FIME-UANL, Mexico.* The erbium doped fiber is modeled as the combination of a linear and circular distributed retarder. Data analysis is performed using Stokes vectors, Mueller calculus and the Poincaré description of polarization.

JWA15
Optical Limiting and Raman Amplification in Silicon Waveguides, *Tak Keung Liang, Hon Ki Tsang; The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We investigate the effect of two-photon absorption and free-carrier absorption for continuous-wave light propagation in sub-micron silicon wire waveguides, and experimentally observe net optical gain from stimulated Raman scattering in a silicon rib waveguide.

JWA16
100-nm Cascaded Hybrid Doped Fiber Amplifier for Coarse Wavelength Division Multiplexing, *Scott S. Yam[1], Youichi Akasaka[2], Yoshinori Kubota[3], Hiroyuki Inoue[4]; [1]Queen's Univ., Canada, [2]Sprint Advanced Technology Labs, USA, [3]Optical Device Development, Central Glass Co. Ltd., Japan, [4]Inst. of Industrial Science, Univ. of Tokyo, Japan.* A hybrid amplifier spanning from 1468-1568nm is constructed by cascading a Thulium-doped fiber amplifier pumped at 690nm and 1400nm and a Cerium co-doped high concentration wideband Erbium-doped fiber amplifier.

6:00 p.m.–7:30 p.m.
JWA • Poster Session II

► Category C: PMD and CD Compensation

JWA17
Ultimate Performance and Limitations of Optical PMD Compensators Controlled by a Spectrum Monitor, *Marco Secondini, Enrico Forestieri, Giancarlo Prati; Scuola Superiore Sant'Anna, Italy.* The suitability of a spectrum monitor for controlling an optical PMD compensator is investigated. Both ideal and practical monitor implementations are considered and compared, and ultimate performance and limitations given.

JWA18
Multi-Channel PMD Compensation Based on Distributed Polarization Control, *Seung Pil Jung, Jun Haeng Lee, Eui Seung Son, Ho Chul Ji, Yun Chur Chung; KAIST, Republic of Korea.* We proposed a multi-channel PMD compensation technique based on the distributed polarization control. The results show that the proposed technique had better performance than the multi-channel PMD compensation technique using single PMD compensator.

JWA19
Novel Type of PMD Compensator Based on Separation of PSP and DGD Controls, *Ki Ho Han, Wang Joo Lee, Hyun Woo Cho, Je Soo Ko; Electronics Telecommunications Res. Inst., Republic of Korea.* We propose and experimentally demonstrate novel type of PMD compensator (PMDC) that separates PSP control from DGD control with an automatically adaptive 40Gb/s PMDC module manufactured in PCB. The performance showed very fast response time of ~2us to PSP change.

JWA20
Multi-Channel Residual Dispersion Compensation in a 40 Gb/s WDM System Utilizing a Single All-Fiber Delay Line Filter, *Thomas Duthel[1], Sander L. Jansen[2], Peter M. Krummrich[3], Michael Otto[4], Christian G. Schäffer[1]; [1]Gesellschaft für Wissens- und Technologietransfer der TU Dresden mbH, Germany, [2]COBRA Inst., Eindhoven Univ. of Technology, Netherlands, [3]Information and Communication Networks, Optical Solutions, Siemens AG, Germany, [4]Inst. für Nachrichtentechnik, Technische Univ. Dresden, Germany.* We demonstrate multi-channel residual dispersion compensation in a 40 Gbit/s optical transmission system with 100 GHz channel spacing using a single adaptive all-fiber delay line filter. The device is based on 3x3 fiber couplers.

JWA21
Tunable Dispersion Compensator with Twin Chirped Fiber Gratings for Polarization Mode Dispersion and Chromatic Dispersion, *Kiichi Yoshiara, Masakazu Takabayashi, Sadayuki Matsumoto, Yasuhisa Shimakura, Takashi Sugihara; Mitsubishi Electric Corp., Japan.* We have developed new tunable dispersion compensators with twin chirped fiber gratings for polarization mode dispersion and chromatic dispersion, simultaneously, and successfully demonstrated, independently. The validity of this device was confirmed by simulations of 43 Gbit/s CS-RZ.

JWA22
PMD Mitigation Application of MZI-SOA Based Optical 2R Regeneration in the Receiver, *Youichi Akasaka[1], Zuqing Zhu[2], Zhong Pan[2], S. J. Ben Yoo[2]; [1]Sprint, Advanced Technology Lab, USA, [2]Univ. of California at Davis, USA.* We propose a new application of the MZI-SOA-based optical-2R regeneration, which can exactly compensate for the PMD penalty resulting from 35ps-DGD in a 10Gb/s system with 18dB OSNR/0.1nm. This demonstrates the effectiveness of optical-2R in the receiver for PMD mitigation.

► Category D: Fiber Devices

JWA23
A High-Speed Tunable Filter Using a Concave Fiber Mirror, *Yunhae Yeh[1], Young Choi[2], Henry F. Taylor[3]; [1]Kyung Hee Univ., Republic of Korea, [2]LambdaQuest Corp., USA, [3]Texas A&M Univ., USA.* A tunable Fabry-Perot filter using a concave mirror fabricated on a fiber end is demonstrated. The concave mirror simplifies alignment and reduces vibration sensitivity. A scanning rate of 150 kHz over a FSR with a finesse of 600 was demonstrated.

JWA24
4x4 Hard Polymer Clad Fiber (HPCF) Splitter for Short Reach PON System Based on HCPF, *Sangchul S. Bae, Kyunghwan K. Oh; Gwangju Inst. of Science and Technology, Republic of Korea.* We report a 4x4 HPCF splitter using a novel fusion-tapering technique, which showed an insertion loss of 10.50dB, excess loss of 4.58dB with excellent uniformity in power splitting ratio. Eye patterns for 1.24 and 2.5Gbps at 820nm were also measured.

JWA25
Highly Efficient Fused-Type Core-Cladding Mode Coupler, *Sang Hoon Lee, Kwang Yong Song, Byoung Yoon Kim; Korea Advanced Inst. of Science and Technology, Republic of Korea.* We demonstrate a novel fused-type mode-selective coupler that couples the LP13 cladding mode in one fiber to the LP01 core mode in another fiber around 1550 nm. The coupling efficiency of 70% was achieved.

JWA26
Novel Spectral Filters Based on Holely Fiber Tapers and Fused Taper Couplers, *Woojin Shin, Soan Kim, G. Hugh Song, K. Oh; Kwangju Inst. of Science and Technology, Republic of Korea.* We report novel transmission characteristics of index guiding holey fiber adiabatic tapers and fused taper couplers. Various spectral functionalities of filters were designed using BPM and spectral responses were experimentally demonstrated.

JWA27
Four-Port Optical Filter Fabricated from Tapered Optical Fiber, *Timothy E. Dimmick, Kevin R. Harper, Douglas J. Markos, David M. Thomas; Harris Corp., USA.* We propose and demonstrate a four-port optical filter fabricated from tapered optical fiber. The device is fabricated from tapered fiber loops wrapped around a low index rod.

► Category E: Lasers

JWA28
100mW Phase-Shifted 1550nm BH DFB Arrays with 10-Micron Pitch, *Sarah Zou, Gideon Yoffe, Bo Lu, John Heanue, Mark Emanuel, Gurinder Parhar, Bardia Pezeshki; Santur Corp., USA.* Very high yield arrays with excellent linewidth, RIN, and SMSR are demonstrated. In a tunable laser application, we obtained 50mW fiber coupled power over a 39nm continuous tuning range by temperature tuning from 15°C to 45°C.

JWA29
Widely Wavelength Tunable Optical Clock Generation by Use of Injection Locked DBR Lasers with Vernier Gratings, *Mitsunobu Gotoda, Satoshi Nishikawa, Tetsuya Nishimura, Yasunori Tokuda; Mitsubishi Electric Corp., Japan.* We propose a versatile optical clock generation method with 10 nm wavelength tunability using widely tunable DBR lasers. Injection locking was experimentally demonstrated for 30 GHz sinusoidal pulses at 1545 and 1560 nm as well.

JWA30
Experimental Investigation of the Signal Degradation in WDM Transmission through Coherent Crosstalk Caused by a Fast Tunable SG-DBR Laser, *Ben Puttnam, Michael Dueser, Polina Bayvel; Univ. College London, UK.* Novel results are presented on thermally induced wavelength drift in a fast tunable SG-DBR laser and the signal impairments caused in a 10 Gb/s transmission system through coherent crosstalk generated during each wavelength switching process.

JWA31
Design and Fabrication of a Micro-Cavity Laser with Transparent Micro Loop Mirror, *Yingyan Huang[1], Yegao Xiao[1], Guoyang Xu[1], Seng-Tiong Ho[1], Yiguang Zhao[2], Chongyang Luo[2], Jane Wang[2], Boonsiew Ooi[3]; [1]Northwestern Univ., USA, [2]Phosistor Technologies, Inc., USA, [3]Lehigh Univ., USA.* We describe a linear laser with micro loops as end mirrors. FDTD simulation is used to design the mirror and laser cavity. Initial fabrication result with threshold of 0.4mA is presented.

6:00 p.m.–7:30 p.m.
JWA • Poster Session II

▶ Category E: Devices for All-Optical Processing

JWA32
Fundamental Limitations of Slow-Light Optical Buffers, *Rodney S. Tucker, Pei-Cheng Ku, Constance J. Chang-Hasnain; Univ. of California at Berkeley, USA.* We show that slow-light optical delay-line buffers are constrained by fundamental physical limitations. We compare the capabilities of a variety of buffer technologies including electromagnetically induced transparency, population pulsations, photonic crystal filters, and fibre-based delay lines.

JWA33
Link Performance of Slow Light All-Optical Buffers, *Pei-Cheng Ku, Connie J. Chang-Hasnain, Rod S. Tucker; Univ. of California, USA.* We analyze the link performance of an optical buffer using slow light as the delay mechanism. A power penalty of a few dBm is found for a 40 Gb/s link. We show the existence of a bandwidth-storage product trade-off.

JWA34
Blind-FROG in a Quasi-Phase-Matched $LiNbO_3$ Waveguide, *Jerry Prawiharjo[1], Katia Gallo[1], Benn C. Thomsen[1,2], Michael A. Roelens[1], Paolo J. Almeida[1], Neil G. Broderick[1], David J. Richardson[1]; [1]Univ. of Southampton, UK, [2]Univ. College London, UK.* We demonstrate the measurement of short pulses in the 1.55 µm telecommunications window by spectrally resolved cross correlation in an integrated $LiNbO_3$ device. Extremely high quality pulse retrieval is obtained for pulsewidths down to 4 ps.

JWA35
Extremely Low-Power Intensity Autocorrelation and Chromatic Dispersion Monitoring for 10-GHz, 3-ps Optical Pulses by Aperiodically Poled Lithium Niobate (A-PPLN) Waveguide, *Shang-Da Yang[1], Zhi Jiang[1], Andrew M. Weiner[1], Krishnan R. Parameswaran[2], Martin M. Fejer[3]; [1]Purdue Univ., USA, [2]JDS Uniphase, USA, [3]Stanford Univ., USA.* We demonstrate intensity autocorrelation of 10-GHz, 3-ps pulses at -43 dBm average input power with an A-PPLN waveguide. Chromatic dispersion monitoring at -45 dBm and 100-ms sampling time is also demonstrated.

JWA36
Passively Mode-Locked 10-GHz 1.3-µm Nd:vanadate Laser for RZ Pulse Generation, *Lukas Krainer[1,2], Gabriel J. Spühler[1,2], Valeria Liverini[1], Silke Schön[1], Rachel Grange[1], Markus Haiml[1], Bruno Graf[3], Hans P. Gauggel[1], Ursula Keller[1]; [1]ETH Zurich, Switzerland, [2]GigaTera, Switzerland, [3]Avalon Photonics Ltd., Switzerland.* We demonstrate a diode-pumped, passively mode-locked $Nd:YVO_4$ (vanadate) laser with a repetition rate of 10 GHz emitting at 1.34 µm. Passive mode locking was achieved by using a novel GaInNAs based saturable absorber mirror.

▶ Category F: Polarization and PMD

JWA37
PMD Induced Penalty in the Presence of Fast Polarization Scrambling, *William Shieh; Univ. of Melbourne, Australia.* PMD induced penalty is investigated for an optical signal in a PMD medium under fast polarization scrambling. The Q penalty from pulse distortion is complementary to the Q penalty from timing jitter.

JWA38
Adaptive PMD Compensation for 170 Gbit/s RZ Transmission Systems with Alternating Polarisation, *Michael Schmidt[1], Martin Witte[1], Fred Buchali[1], Eugen Lach[1], Henning Buelow[1], Erwan Corbel[2]; [1]Alcatel R&I, Germany, [2]Alcatel R&I, France.* We report on adaptive PMD compensation in a 170 Gbit/s RZ transmission system with alternating polarisation. The PMD tolerance is significantly improved using an asymmetric rather than symmetric setup of the two-stage PMD compensator.

JWA39
Differential Polarization-Phase-Shift Keying without Using Polarization Control, *Yan Han, Guifang Li; Univ. of Central Florida, CREOL, USA.* We propose a novel modulation format that polarization and phase of lightwave can be differentially detected without using polarization control at the receiver. 20 Gb/s transmission through 25 spans of 100 km SMF is possible.

JWA40
Influence of Polarization Scattering on Polarization-Assisted OSNR Monitoring in Dense WDM Systems with NZ-DSF and Raman Amplification, *Chongjin Xie, Daniel C. Kilper; Bell Labs, Lucent Technologies, USA.* We show experimentally that the inter-channel XPM induced polarization scattering can cause large errors for polarization-assisted OSNR monitoring techniques in a dense WDM system with NZ-DSF, Raman amplification and RZ modulation signals.

JWA41
Polarization Interleaving to Reduce Inter-Channel Nonlinear Penalties in Polarization Multiplexed Transmission, *Dirk van den Borne[1], Sander Lars Jansen[1], Giok-Djan Khoe[1], Huug de Waardt[1], Stefano Calabrò[2], Nancy E. Hecker-Denschlag[2]; [1]COBRA Inst., Eindhoven Univ. of Technology, Netherlands, [2]Siemens AG, ICN Carrier Products, Germany.* We investigate through simulations and experiments inter-channel nonlinear penalties in 2x10Gbit/s NRZ polarization-multiplexed transmission. We show that the inter-channel nonlinear penalties can be partially mitigated by polarization interleaved transmission of the polarization-multiplexed channels.

▶ Category G: Optical Signals

JWA42
Chirp Reduction of $\pi/2$ Alternate-Phase Pulses by Optical Filtering, *Xing Wei, Juerg Leuthold, Christophe Dorrer, Douglas M. Gill, Xiang Liu; Lucent Technologies, USA.* We experimentally demonstrate that the frequency chirp in sinusoidal-phase-modulated $\pi/2$ alternate-phase pulses can be greatly reduced by optical filtering. A theoretical analysis shows the optimal modulation depth is approximately 0.56π.

JWA43
A Novel Optical Frequency Shift Keying Transmitter Based on Polarization Modulation, *Siu-Sun Pun, Chun-Kit Chan, Lian-Kuan Chen; The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We propose and experimentally demonstrate a novel optical frequency shift keying transmitter based on polarization modulation that features bit rate transparency and continuous tuning of wavelength spacing. The performance of the transmitter has been further experimentally characterized.

JWA44
All-Optical Incoherent Negative-Tap Microwave Filter Using the Phase Inversion of a Single Electro-Optic Modulator, *Borja Vidal, Juan L. Corral, Javier Marti; Fiber Radio Group, Spain.* A novel all-optical negative-tap microwave filter based on multiple optical carriers and a dispersive medium is demonstrated. Using the π-phase inversion in a single electro-optic modulator and the modulator $V\pi$ dependence with wavelength, negative coefficients are obtained.

JWA45
All-Optical SCM-to-TDM Label Format Converters for Interoperating Optical-label Switching Networks, *Zuqing Zhu, Zhong Pan, S. J. Yoo; Univ. of California at Davis, USA.* We propose and demonstrate all-optical label-encoding format conversion from subcarrier-multiplexing to time-domain-multiplexing for 156.25 Mb/s labels and 10 Gb/s payload. The experiments show error-free operations for with only 0.41 dB normalized power penalty for payload.

▶ Category G: Novel Transmission Technologies

JWA46
Bidirectional Single Fiber Transmission Based on a RSOA ONU for FTTH Using FSK-IM Modulation Formats, *Cristina Arellano, Victor Polo, Carlos Bock, Josep Prat; UPC, Spain.* Full-duplex bidirectional transmission using FSK modulation for downstream and Remote IM using a Reflective SOA for upstream in a single-fiber WDM-PON access network is demonstrated. The system shows proper operation at 1Gbit/s to 30km reach.

6:00 p.m.–7:30 p.m.
JWA • Poster Session II

JWA47
All-Optical Add-Drop Node for Packet-Switched Networks, *P. K. A. Wai[1], Lixin Xu[1,2], L. F. K. Lui[1], L. Y. Chan[1], C. C. Lee[1], H. Y. Tam[1], M. S. Demokan[1]; [1]Photonics Res. Ctr. and Dept. of Electronic and Information Engineering, Hong Kong Polytechnic Univ., Hong Kong Special Administrative Region of China, [2]Dept. of Physics, Univ. of Science and Technology of China, China.* We demonstrated all-optical packet add/drop for all-optical packet-switched networks. Intelligent all-optical add-drop of packets is performed based on all-optical processing of packet headers. The header and payload rates are 5 Gb/s and 10 Gb/s respectively.

JWA48
Experimental Demonstration of 2 x 10 Gb/s OCDMA System Using Cascaded Long-Period Fiber Gratings Formed in Dispersion Compensating Fiber, *Sun-Jong Kim, Tae Joong Eom, Tae-Young Kim, Byeong Ha Lee, Chang-Soo Park; Gwangju Inst. of Science and Technology, Republic of Korea.* A 2 x 10 Gb/s OCDMA system using cascaded long-period fiber gratings formed in dispersion compensating fiber with inner-cladding structure is presented. Two encoder/decoder pairs are fabricated and the coding performances between them are verified with BER measurement.

JWA49
Design and Demonstration of Gigabit Spectrum-Sliced WDM Systems Employing Directly Modulated Super Luminescent Diodes, *Jun-ichi Kani, Hideo Kawata, Katsumi Iwatsuki, Akira Ohki, Mitsuru Sugo; NTT, Japan.* For realizing spectrum-sliced WDM systems with over 1Gbps per channel, this paper elucidates the slicing bandwidth that maximizes the loss budget between transmitters and receivers as well as demonstrates a directly modulated super luminescent diode.

▶ *Category H: Restoration and Fault Management*

JWA50
Experimental GMPLS Fault Management for OULSR Transport Networks, *Raul Munoz[1], Carolina Pinart[2], Ricardo Martinez[1], Manuel Requena[1], Abdelhafid Amrani[1], Jordi Sorribes[2], Gabriel Junyent[2]; [1]CTTC, Spain, [2]UPC, Spain.* This paper presents a novel GMPLS-based fault management architecture for OULSR rings tested in the ADRENALINE testbed. Experimental results show an optical protection delay of 45ms using SNMP-based monitoring and IP/control restoration delays around 2100ms.

JWA51
On Wavelength Management for Restoration in WDM Ring Networks, *Dongmei Wang, Guangzhi Li, Angela L. Chiu; AT&T Labs, USA.* This paper discusses two schemes of managing wavelengths for restoration in WDM ring networks. Our results show that clever management scheme with Ltd. transparent ring interconnection would improve the wavelength utilization up to 71%

JWA52
Using MCG to Find PP-Cycles in Planar Graphs, *Wail Mardini, Oliver Yang, Yihua Zhai; Univ. of Ottawa, Canada.* We present a detailed study on finding p-cycles. Called pp-cycles (planar p-cycle), they can take the geographical nature of the network into account and protecting all links within same area. An algorithm that exploits all these properties is implemented and tested.

▶ *Category H: PONS and Access Networks*

JWA53
A Novel Star-Ring Protection Architecture Scheme for WDM Passive Optical Access Networks, *Xiaofeng Sun, Zhaoxin Wang, Chun-Kit Chan, Lian-Kuan Chen; The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We propose and demonstrate a star-ring network architecture and wavelength assignment scheme for multi-wavelength passive optical networks with full path protection capability. Bi-directional traffic can be restored promptly for single/multiple link failure scenarios.

JWA54
AWG Misalignment Tolerance of 16 x 155 Mb/s WDM-PON Based on ASE-Injected FP-LDs, *Dong J. Shin, Dae K. Jung, Hong S. Shin, Sung B. Park, Hyun S. Kim, Sang H. Kim, Seongtaek Hwang, Eun H. Lee, Jung K. Lee, Yoon K. Oh, Yun J. Oh; Samsung Electronics, Republic of Korea.* Crosstalk penalties from adjacent and nonadjacent channels are experimentally analysed as a function of wavelength misalignment between AWGs at remote node and central office in a 16 x 155 Mb/s WDM-PON based on ASE-injected FP-LDs.

JWA55
Dense WDM-PON Based on Wavelength Locked Fabry-Perot Lasers, *Sang-Mook Lee, Ki-Man Choi, Sil-Gu Mun, Jung-Hyung Moon, Chang-Hee Lee; Korea Advanced Inst. of Science and Technology, Republic of Korea.* We demonstrate 12-channel WDM-PON with 50 GHz channel spacing based on low cost wavelength locked Fabry-Perot laser diodes. The proposed WDM-PON can accommodate 80 channels with EDFA based broadband light source.

JWA56
VDSL Transmission over Latin Routed DWDM Optical Access Networks, *Manoj P. Thakur, Ioannis Tsalamanis, Jason J. Lepley, Stuart D. Walker; Univ. of Essex, UK.* We present a novel architecture for sub-carrier multiplexed VDSL transmission utilising cascaded arrayed-waveguide grating optical access network. In particular, triple play was achieved with both DMT and QAM based VDSL modems.

JWA57
Bidirectional Wavelength-Division-Multiplexing Self-Healing Passive Optical Network, *Sung-Bum Park, Dae Kwang Jung, Dong Jae Shin, Hong Seok Shin, Seongtaek Hwang, Yun Je Oh, Chang Sup Shim; Telecommunication R&D Ctr., Republic of Korea.* We demonstrate a bidirectional wavelength-division-multiplexing (WDM) self-healing passive optical network (PON), which can provide 1+1 protection capability. In this network, self-healing can be achieved within 8 ms against any fiber cut of the feeder fiber and the distribution fiber.

JWA58
Self-Amplified Passive Optical Network Using 8B10B Line Coding Properties in Gigabit-Ethernet Protocol, *Mun Seob Lee, Byung-Tak Lee, Hyun Seo Kang, Hee Sang Chung, Jai Sang Koh; Electronics and Telecommunications Res. Inst., Republic of Korea.* A cost-effective self-amplified network in gigabit-ethernet passive optical network is demonstrated using 8B10B line coding properties. We explain the operational principles and experimental results including transmitter and receiver margin for an upstream channel.

JWA59
Optical Wireless Networks: Transceiver Distribution Provisioning, *Ahmed M. Mahdy, Jitender S. Deogun; Univ. of Nebraska at Lincoln, USA.* We propose a transceiver-distribution provisioning heuristic for optimized optical wireless networks. Simulation results show that networks adapting proposed heuristic outperform on load balance, link usage, and average packet delay by 37%, 29%, and 17%, respectively, compared to unplanned transceiver distribution.

JWA60
Performance Evaluation for Wireless LAN, Ethernet and UWB Co-Existence on Hybrid Radio-over-Fiber Picocells, *M. L. Yee, C. K. Sim, B. Luo, L. C. Ong, M. Y. W. Chia; Inst. for Infocomm Res., Singapore.* The performance of IEEE802.11a and Gigabit Ethernet coexisting with Ultra-Wideband is evaluated in a low-cost VCSEL-based ROF channel for wired and wireless picocell applications. Experimental results showing such services in an ROF environment of various lengths are presented.

▶ *NFOEC Posters*
(See page 144 for NFOEC Poster Papers.)

Ballroom A

8:30 a.m.–10:30 a.m.
OThA • Nonlinear Fibers and Effects
Roger H. Stolen; Virginia Tech, USA, Presider

OThA1 • 8:30 a.m.
Transparent Bi_2O_3-Based Nonlinear Optical Fiber with Erbium Doping, *Tomoharu Hasegawa[1], Tatsuo Nagashima[1], Naoki Sugimoto[1], Kazuro Kikuchi[2]; [1]Asahi Glass Co., Ltd., Japan, [2]Univ. of Tokyo, Japan.* An erbium-doped Bi_2O_3-based nonlinear optical fiber is developed to reduce the propagation loss. The significantly enhanced four-wave-mixing and its wavelength dependence reveal that the propagation loss is completely compensated by the Er^{3+} excitation.

OThA2 • 8:45 a.m.
Multi-Step-Index Bismuth-Based Highly Nonlinear Fiber with Low Propagation Loss and Splicing Loss, *Tatsuo Nagashima[1], Tomoharu Hasegawa[1], Seiki Ohara[1], Naoki Sugimoto[1], Kazuro Kikuchi[2]; [1]Asahi Glass Co., Ltd., Japan, [2]Univ. of Tokyo, Japan.* Propagation loss and practical fusion-splicing loss of bismuth-based fibers are reduced to 0.8 dB/m and 2.6 dB/point, respectively, while maintaining high nonlinearity of 1100 $W^{-1}km^{-1}$ by modifying the glass composition and eliminating the cladding mode.

Ballroom B

8:30 a.m.–10:30 a.m.
OThB • Microwave Photonics
Dalma Novak; Univ. of Melbourne, Australia, Presider

OThB1 • 8:30 a.m. Tutorial
Microwave Signal Processing Using Optics, *Jose Capmany; Optical Communications Group, IMCO2 Res. Institute, Spain.* We cover the fundamental concepts and applications of photonic filters for Rf, microwave and millimetre signal processing, addressing their two main fields of application: A) Filters for RF systems and applications and B) Filters for Optical Transmission systems and networks.

Jose Capmany was born in Madrid, Spain in 1962. He received the Ingeniero de Telecomunicación and Ph.D. degrees from the Universidad Politécnica de Madrid in 1987. He is currently at the Departamento de Comunicaciones, Universidad Politécnica de Valencia since 1991, and is now full professor in optical communications, systems and networks since 1996.

Capmany has published over 200 papers in international refereed journals and conferences, conducted over 25 research projects and has been a member of the Technical Program Committees of the European Conference on Optical Communications (ECOC) and the Optical Fiber Communication Conference (OFC) amongst others. He is the current chairman of the LEOS Spanish Chapter, a Fellow of OSA and the Institution of Electrical Engineers (IEE). Capmany is also a member of the editorial board of several

Ballroom C

8:30 a.m.–10:30 a.m.
OThC • System Measurements and Studies
Itsuro Morita; KDDI R&D Labs, Japan, Presider

OThC1 • 8:30 a.m.
Modeling RZ-DPSK Transmission—Simulations and Measurements for an Installed Submarine System, *William T. Anderson, Li Liu, Yi Cai, Alexei Pilipetskii, Jin-Xing Cai, Michael Vaa, Morten Nissov, Dmitriy Kovsh; Tyco Telecommunications, USA.* We model RZ-DPSK transmission in an installed 6,550 km trans-Atlantic submarine system. Simulations agree well with measurements. Simulations predict that nonlinear noise will not eliminate the RZ-DPSK advantage over RZ-OOK even for trans-Pacific distances.

OThC2 • 8:45 a.m.
Study of Polarization Driven Q Fluctuations on Deployed Undersea Fiber Systems, *Alexei N. Pilipetskii, Lee J. Richardson, Ekaterina A. Golovchenko, Alan J. Lucero, Carl R. Davidson; Tyco Telecommunications, USA.* We use a simple model to analyze the polarization driven performance fluctuations in an optical transmission system. The model shows good agreement with data accumulated over a long period of time on deployed systems

Ballroom D

8:30 a.m.–10:30 a.m.
OThD • MEMS
Dan M. Marom; Bell Labs, Lucent Technologies, USA, Presider

OThD1 • 8:30 a.m. Invited
Tunable MEMS Devices for Reconfigurable Optical Networks, *Jill D. Berger, Doug Anthon, Subrata Dutta, Fedor Ilkov, I-Fan Wu; Iolon Inc., USA.* Transmitters and receivers based on MEMS-tuned external cavity diode lasers and diffraction grating filters deployed in reconfigurable optical networks provide up to 6.4 THz tuning in 15 ms with ±1.25 GHz frequency accuracy and superior optical performance in compact packages.

Notes

Ballroom E

8:30 a.m.–10:30 a.m.
OThE • All-Optical Signal Processing II
Leo Spiekman; Genexis, Netherlands, Presider

OThE1 • 8:30 a.m. Invited
Design and Applications of All-Optical Regenerators, *Jiten Sarathy; Alphion Corp., USA.* The applications and design considerations that drive the development of InP-based all-optical regenerators are summarized.The applications of the 2R regenerator are enumerated along with the design considerations for the fabrication of these devices.

Room 303A-B

8:30 a.m.–10:30 a.m.
OThF • Raman Amplifiers
Jake Bromage; Univ. of Rochester, USA, Presider

OThF1 • 8:30 a.m.
Noise Induced by Distributed Raman Amplification in a Forward-Pumping Scheme Using FBG-Stabilized Diodes, *Catherine Martinelli, Anne Durécu-Legrand, Laurence Lorcy, Dominique Mongardien, Dominique Bayart; Alcatel, Res. and Innovation Dept., France.* Forward Raman amplification using FBG-stabilized diodes yields higher signal RIN than expected from the Raman-gain-mediated transfer function. We demonstrate that this extra noise originates from pump-signal nonlinear parametric interactions even far from the phase-matching condition.

OThF2 • 8:45 a.m.
40 Gb/s WDM-Transmission with EDFAs in Comparison to Raman Amplified Transmission with Raman Fiber Lasers as First-Order and Second-Order Pump, *Elmar Schulze, Andreas Warnke, Friedrich Raub; Heinrich-Hertz-Inst., Germany.* We investigated a 16 x 40 Gb/s long-haul transmission to prove whether Raman fiber lasers can replace LDs used for co-directional second-order pumped Raman amplifiers (RA) and compared the RA to counter pumped RA and EDFAs.

Room 303C-D

8:30 a.m.–10:30 a.m.
OThG • Access Networks
Mark Feuer; AT&T, USA, Presider

OThG1 • 8:30 a.m. Invited
Advances in Optical Access Networks, *Glen Kramer[1], Keiji Tanaka[2]; [1]Teknovus, USA, [2]KDDI R&D Labs, Japan.* EPON standard (IEEE 802.3ah) only covers physical and data link layers; the rest is considered out-of-scope. This article explores several interesting research problems brought forward by EPON architecture, but left out by the standard.

Room 304A-B

8:30 a.m.–10:30 a.m.
OThH • Performance Monitoring
Klaus Petermann; TU Berlin, Germany, Presider

OThH1 • 8:30 a.m.
In-Line Signal Quality Monitoring Based on Asynchronous Amplitude Histogram for NRZ-DPSK Systems, *Zhihong Li[1], Yixin Wang[1], Chao Lu[1,2]; [1]Inst. for Infocomm Res., Singapore, [2]School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore.* We have demonstrated novel in-service signal quality monitoring technique for constant amplitude NRZ-DPSK signal using asynchronous amplitude histogram evaluation. Information about dispersion and OSNR can be directly extracted from the amplitude histogram of NRZ-DPSK signal.

OThH2 • 8:45 a.m.
A Novel Broadband Asynchronous Histogram Technique for Optical Performance Monitoring, *Sarah D. Dods[1], Peter M. Farrell[2], Kerry Hinton[3], Don F. Hewitt[1]; [1]Australian Photonics Cooperative Res. Ctr., Photonics Res. Lab, Australia, [2]Natl. ICT Australia, Victoria Res. Lab, Australia, [3]Univ. of Melbourne, Australia.* We combine tunable narrowband filtering with asynchronous sampling to produce broadband histograms that measure frequency-resolved signal distortion. We demonstrate the technique using chirped WDM signals affected by filter detuning, dispersion and nonlinear effects.

Notes

Ballroom A

OThA • Nonlinear Fibers and Effects—Continued

OThA3 • 9:00 a.m.
Heavy Metal Oxide Glass Holey Fibers with High Nonlinearity, *Heike Ebendorff-Heidepriem, Periklis Petropoulos, Vittoria Finazzi, Simon Asimakis, Julie Leong, Fumihito Koizumi, Ken Frampton, Roger C. Moore, David J. Richardson, Tanya M. Monro; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We report on the development of small-core high-NA lead silicate and bismuth glass holey fibers. We measured high nonlinearity (1100 W^{-1} km^{-1} in bismuth holey fiber) and predicted near-zero or anomalous dispersion at 1550 nm.

OThA4 • 9:15 a.m.
Generation of Ultra-Flat SPM-Broadened Spectra in a Highly Nonlinear Fiber Using Pulse Pre-Shaping in a Fiber Bragg Grating, *Paulo J. Almeida, Periklis Petropoulos, Morten Ibsen, David J. Richardson; Univ. of Southampton, UK.* We propose a new approach to generating spectrally flat supercontinuum pulses based on seeding a commercial nonlinear fibre with pump pulses shaped using a super-structured fiber Bragg grating. Experimental results confirm the viability of the approach.

OThA5 • 9:30 a.m.
Single-Mode High-Index-Core One-Dimensional Microstructured Fiber with High Nonlinearity, *Xian Feng, Tanya M. Monro, Periklis Petropoulos, Vittoria Finazzi, David J. Richardson; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We report the first fabrication of high-index-core one-dimensional microstructured optical fiber with high index-contrast layers. Extrusion is utilized to fabricate the microstructured preform. Single mode guidance and high nonlinearity were observed in the fiber.

Ballroom B

OThB • Microwave Photonics—Continued

scientific journals and has been a guest editor of IEEE JSTQE on Arrayed Waveguide grating devices.

OThB2 • 9:30 a.m.
Microwave Signal Transmission over a Directly-Modulated Radio-over-Fiber Link Using Cascaded Semiconductor Optical Amplifiers, *Xin Qian, Peter Hartmann, Adrian Wonfor, Jonathan D. Ingham, Richard V. Penty, Ian H. White; Dept. of Engineering, Univ. of Cambridge, UK.* We demonstrate a record 150km transmission of microwave signals by a directly-modulated radio-over-fiber link with a bit-error-rate of less than 10-12. Cascaded semiconductor optical amplifiers are employed in this link to extend the transmission link length.

Ballroom C

OThC • System Measurements and Studies—Continued

OThC3 • 9:00 a.m. Invited
DPSK Performance in Field and Laboratory Experiments, *Dimitri G. Foursa; Tyco Telecommunications, USA.* Recent long-haul laboratory and field studies using the DPSK format are discussed. Comparison with OOK performance is presented. DPSK performance is discussed with respect to a number of system parameters.

OThC4 • 9:30 a.m.
32 x 11.4 Gbit/s Transmission over 4000 km Using Dispersion Managed 200 km Spans, *Akira Hagisawa, Noriyuki Takeda, Eiichi Shibano, Hidenori Taga, Koji Goto; KDDI Submarine Cable Systems Inc., Japan.* We have transmitted 32 x 11.4 Gbit/s signals over 4000 km using 200 km spans with pump power applicable for undersea cable system. We believe that the result shows the feasibility of the 200 km spans for undersea cable system.

Ballroom D

OThD • MEMS—Continued

OThD2 • 9:00 a.m.
Micro-Machined XY Stage for Fiber Optics Module Alignment, *Marc Epitaux[1], Jean-Marc Verdiell[1], Yves Pétremand[2], Wilfried Noell[2], Nicolaas F. De Rooij[2]; [1]Intel, USA, [2]Inst. of Microtechnology, Univ. of Neuchâtel, Switzerland.* A novel Silicon micro-machined XY stage with a hybrid micro-lens for fiber optics module alignment is presented. MEMS micro-alignment method and Silicon chip design are described. Finally the micro-fabricated device performance is discussed.

OThD3 • 9:15 a.m.
Development of MEMS-Based Optical Surge Suppressor, *Toru Hirata[1], Ichiro Mitama[1], Masahiro Abe[1], Kikuo Makita[2], Kazuhiro Shiba[2], Kazuhiro Hane[3], Minoru Sasaki[3]; [1]Sumitomo Heavy Industries, Ltd., Japan, [2]NEC Corp., Japan, [3]Tohoku Univ., Japan.* A MEMS-based optical surge suppressor is proposed. The device consists of MEMS-shutter and photovoltaic detector that triggers the shutter through in-line monitoring of surge light around power level of 10dBm with insertion loss of 1.5dB.

OThD4 • 9:30 a.m. Tutorial
Current Trends in MEMS, *Ming Wu; Univ. of California at Berkeley, USA.* A wide range of MEMS technologies were developed during the telecom boom. Not all of them survived the downturn. This tutorial will discuss the current trends in Optical MEMS that emphasize integration and cost effectiveness.

Notes

Ballroom E

OThE • All-Optical Signal Processing II—Continued

OThE2 • 9:00 a.m.
40 Gb/s Fast-Locking All-Optical Packet Clock Recovery, *Leontios Stampoulidis[1], Efstratios Kehayas[1], Hercules Avramopoulos[1], Yong Liu[2], Eduward Tangdiongga[2], Harmen J. Dorren[2]; [1]Natl. Technical Univ. of Athens, Greece, [2]Eindhoven Univ. of Technology, Netherlands.* We demonstrate instantaneous 40 Gb/s clock extraction from 1 ns long data packets separated by 750 ps. The circuit comprises a Fabry-Perot filter, an all-optical power limiting gate, and requires very short inter-packet guardbands.

OThE3 • 9:15 a.m.
40Gbps Operation of an Offset Quantum Well Active Region Based Widely-Tunable All-Optical Wavelength Converter, *Vikrant Lal, Milan L. Masanovic, Joseph A. Summers, Larry A. Coldren, Daniel J. Blumenthal; Univ. of California at Santa Barbara, USA.* We demonstrate for the first time 40Gbps operation of a quantum well based monolithically-integrated widely-tunable all-optical wavelength converter. We show open eyes at 40GbpsRZ with an output switching window of 6ps and low pattern dependence across a 25nm output tuning.

OThE4 • 9:30 a.m.
Experimental Demonstration of Femtosecond Switching of a Fully Packaged All-Optical Switch, *Chee Kim Yow[1], Yew Jun Chai[1], Dimitri Reading-Picopoulos[1], Richard Vincent Penty[1], Ian Hugh White[1], Christopher G. LeBurn[2], Alexander A. Lagatsky[2], Alan McWilliam[2], C. T. Brown[2], Wilson Sibbett[2], Graeme Maxwell[3], Robert McDougall[3]; [1]Univ. of Cambridge, UK, [2]Univ. of St. Andrews, UK, [3]Ctr. for Integrated Photonics, UK.* We experimentally demonstrate femtosecond switching of a hybrid-integrated Mach-Zehnder switch. A record switching speed of 620fs at full-width-half-maximum is achieved.

Room 303A-B

OThF • Raman Amplifiers—Continued

OThF3 • 9:00 a.m.
Third-Order Cascaded Raman Amplification Benefits for 10 Gbits/s WDM Unrepeated Transmission Systems, *Stefano Faralli[1], Simone Sugliani[2], Giovanni Sacchi[2], Fabrizio Di Pasquale[1], Serguei Papernyi[3]; [1]Scuola Superiore Sant'Anna, Italy, [2]Photonic Networks Natl. Lab CNIT, Italy, [3]MPB Communications Inc., Canada.* Benefits provided by third-order Raman pumping in unrepeated WDM transmission systems are quantified in terms of BER performances at 10 Gb/s. Double-Rayleigh scattering noise induces transmission penalties at very high on-off Raman gain and must be kept under control.

OThF4 • 9:15 a.m.
Six-Order Cascaded Raman Amplification, *Serguei Papernyi[1], Vladimir Ivanov[1], Yosushi Koyano[2], Hiroyoshi Yamamoto[2]; [1]MPB Communications Inc., Canada, [2]Sumitomo Electric Industries LTD, Japan.* Sixth-order Raman amplification is demonstrated for the first time and shown to provide >10 dB budget improvement. Raman amplifiers of differing orders are compared in several commercial fibers and optimal Raman gains are presented.

OThF5 • 9:30 a.m. Invited
High-Performance Distributed Raman Amplification Systems: Practical Aspects and Field Trial Results, *Hiroji Masuda, Masahito Tomizawa, Yutaka Miyamoto; NTT Network Innovation Labs, Japan.* We introduce high-performance distributed Raman amplification (DRA) systems employing a DRA/EDFA hybrid amplifier scheme with practical aspects based on safety considerations. We also describe successful field trial results using the scheme with high pump-efficiency.

Room 303C-D

OThG • Access Networks—Continued

OThG2 • 9:00 a.m.
A Novel Admission Control System for Bandwidth on Demand Ethernet Services over Optical Transport Networks, *Haidar A. Chamas[1], William Bjorkman[2], Mohamed Ali[1]; [1]GSUC/CUNY, USA, [2]Verizon Communications, USA.* A novel scheme used in conjunction with Multiple Spanning Trees Protocol to control an Ethernet Virtual Connection admission into a Service Provider optical network with the most efficient path selection through the Ethernet Layer-2 network.

OThG3 • 9:15 a.m.
200 km CWDM Transmission Using a Hybrid Amplifier, *Patrick P. Iannone, Kenneth C. Reichmann, Xiang Zhou, Nicholas J. Frigo; AT&T Lab-Res., USA.* We report a 60nm bandwidth SOA-Raman hybrid amplifier for CWDM. The Raman section increases gain, reduces gain tilt, and decreases saturation induced crosstalk. The amplifier is used in a 4-channel, 200-km transmission experiment.

OThG4 • 9:30 a.m.
Quality of Service Support over SUCCESS-DWA: A Highly Evolutional and Cost-Effective Optical Access Network, *Yu-Li Hsueh[1], Matthew S. Rogge[1], Wei-Tao Shaw[1], Shu Yamamoto[2], Leonid G. Kazovsky[1]; [1]Stanford Univ., USA, [2]KDDI Labs, USA, USA.* We investigate the scheduling algorithms with quality of service support for a novel optical access network, the SUCCESS-DWA PON. Results show that the high-priority traffic exhibits good packet delay performance in the proposed scheduling algorithms.

Room 304A-B

OThH • Performance Monitoring—Continued

OThH3 • 9:00 a.m.
PMD-Insensitive DOP-Based OSNR Monitoring by Spectral SOP Measurements, *Mats Sköld, Bengt-Erik Olsson, Henrik Sunnerud, Magnus Karlsson; Photonics Lab, Chalmers Univ. of Technology, Sweden.* We present a DOP-based OSNR monitoring method with spectral SOP measurement to perform OSNR measurements insensitive to PMD. Measurements at OSNR=25 dB and DGD=32% of bitslot is performed with a standard deviation of 0.67 dB.

OThH4 • 9:15 a.m.
High Resolution and High Speed Wavelength-Parallel Polarization Sensor for Dense WDM Systems, *Shawn X. Wang, Shijun Xiao, Andrew M. Weiner; Purdue Univ., USA.* We report on a wavelength-parallel polarization sensor with potential to perform ≤ 4 GHz-spaced sub-channel polarization measurement for multiple Dense WDM channels in parallel, with measurement time of less than 5 ms.

OThH5 • 9:30 a.m.
Quadrature-Mixer Based Receiver for Improved Measurement of the Optical Phase Transfer Function, *David J. Krause, John C. Cartledge; Queen's Univ., Canada.* A RF quadrature-mixer based receiver is used to increase the bandwidth of the stimulus in measuring the optical phase transfer function. The technique is demonstrated for stimuli in the range of 1 kHz to 10 MHz.

Notes

Ballroom A

OThA • Nonlinear Fibers and Effects—Continued

OThA6 • 9:45 a.m.
Forward and Backward Brillouin Scattering in a Holey Fiber, *Yoshinori Inoue, Takamitsu Aiba, Noritaka Taguchi, Shingo Tanaka, Nori Shibata; Optowave Lab, Inc., Japan.* Forward and backward Brillouin scattering spectra are measured for a holey fiber in the 1525-1585 nm wavelength region. Experiments suggest that the existence of air-holes reduces the shear acoustic-velocity with respect to the torsional/radial TR_{2m}-modes.

OThA7 • 10:00 a.m. Invited
Nanowiring Light, *Geoff T. Svacha[1], Limin Tong[2], Eric Mazur[1]; [1]Harvard Univ., USA, [2]Zhejian Univ., China.* Recent advances in the fabrication and manipulation of sub-wavelength optical fibers provide new methods for building chemical and biological sensors, generating supercontinuum light by nonlinear pulse propagation, and constructing microphotonic components and devices.

Ballroom B

OThB • Microwave Photonics—Continued

OThB3 • 9:45 a.m.
Extending Transmission Distance in Wavelength Reused Fiber-Radio Links with FBG Filters, *Manik Attygalle, Christina Lim, Masud Bakaul, Thas Nirmalathas; Univ. of Melbourne, Australia.* We present a simple, passive technique that significantly extends the transmission distance of wavelength reused fiber-radio links. The technique works by optimizing the modulation depth that allows the use of 95-99% reflective fiber Bragg gratings.

OThB4 • 10:00 a.m.
Reciprocating Optical Modulator Using a Resonant Modulating Electrode for Generation of High-Order Double Sideband Components, *Tetsuya Kawanishi[1], Satoshi Shinada[1], Satoshi Oikawa[2], Kiichi Yoshiara[3], Takahide Sakamoto[1], Masayuki Izutsu[1]; [1]Natl. Inst. of Information and Communications Technology, Japan, [2]Sumitomo Osaka Cement, Japan, [3]Mitsubishi Electric, Japan.* We propose and demonstrate a reciprocating optical modulator having a phaseshifted fiber Bragg grating, a tunable fiber Bragg grating, and a resonant-type optical modulator. It enables effective generation of high-order double sideband components.

Ballroom C

OThC • System Measurements and Studies—Continued

OThC5 • 9:45 a.m.
Bit Error Rate Estimation of DPSK Modulated Fiber-Optic Systems Using Multicanonical Monte-Carlo Simulations, *Yoav Yadin[1], Mark Shtaif[2], Meir Orenstein[1]; [1]Technion, Israel, [2]Tel Aviv Univ., Israel.* We report the first implementation of the multicanonical Monte-Carlo simulation method to phase modulated optical communications systems. The method is used to validate a theoretical approach for estimating bit error rates in DPSK systems.

OThC6 • 10:00 a.m. Invited
Evaluation of Partially Loaded Systems, *Eiichi Shibano, Takanori Inoue, Hidenori Taga, Koji Goto; KDDI-SCS Inc., Japan.* Evaluation of partially loaded system is reviewed through experimental verifications. Considering the effects of the newly added signals during upgrade, allocation of dummy lights, replacement of dummy lights and interaction of inter-channels are discussed.

Ballroom D

OThD • MEMS—Continued

Dr. Ming Wu is a Professor of Electrical Engineering and Computer Sciences at the University of California, Berkeley. His research interests include optical MEMS, optoelectronics and biophotonics. He received his B.S. degree from National Taiwan University, and M.S. and Ph.D. degrees from University of California at Berkeley in 1983, 1985 and 1988 respectively, all in Electrical Engineering. Before joining UC Berkeley, Dr. Wu was Member of Technical Staff at AT&T Bell Laboratories (Murray Hill) from 1988 to 1992, and Professor at UCLA from 1993 to 2004. In 1997, Dr. Wu co-founded OMM to commercialize MEMS optical switches. Dr. Wu has published over 380 papers, 4 book chapters, and holds 11 U.S. patents. He is a Packard Fellow, and an IEEE Fellow. Dr. Wu has served in the program committees of many conferences (OFC, CLEO, LEOS, MEMS, Optical MEMS, MWP, IEDM, DRC, ISSCC) and as guest editors of two special issues of IEEE journals on Optical MEMS.

Notes

10:00 a.m.–4:00 p.m. EXHIBIT HALL OPEN

Ballroom E

OThE • All-Optical Signal Processing II—Continued

OThE5 • 9:45 a.m.
Detailed Comparison of Cross-Phase Modulation Efficiency in Offset Quantum Well and Centered Quantum Well Intermixed Monolithically Integrated Widely-Tunable MZI-SOA Wavelength Converters, *Milan Masanovic, Vikrant Lal, Erik Skogen, Jonathon Barton, Joseph Summers, Larry Coldren, Daniel Blumenthal; Univ. of California at Santa Barbara, USA.* We investigate experimentally the cross-phase modulation efficiencies of monolithic tunable all-optical wavelength converters in both offset quantum-well and centered quantum-well intermixed InP integration platforms. CQW exhibit 60% higher efficiency with full 180 degree phase change possible.

OThE6 • 10:00 a.m.
1x4 All-Optical Packet Switch with All-Optical Header Processing, *L. F. Lui[1], Lixin Xu[1,2], L. Y. Chan[1], C. C. Lee[1], H. Y. Tam[1], M. S. Demokan[1]; [1]Hong Kong Polytechnic Univ., China, [2]Dept. of Physics, China.* We demonstrated a 1x4 all-optical packet switch using injection-locking in a Fabry-Perot laser diode for all-optical header processing and cross gain modulation in an SOA for packet switching.

Room 303A-B

OThF • Raman Amplifiers—Continued

OThF6 • 10:00 a.m.
Experimental Performance Comparison for a Variety of Single Pump, Highly Efficient, Dispersion Compensating Raman/EDFA Hybrid Amplifiers, *Ju Han LEE[1], You Min Chang[1], Young-Geun Han[1], Haeyang Chung[2], Sang Hyuck Kim[1], Sang Bae Lee[1]; [1]Korea Inst. of Science and Technology (KIST), Republic of Korea, [2]Kyung Hee Univ., Republic of Korea.* We experimentally compare performance of our proposed single pump, Raman/EDFA hybrid amplifiers recycling residual Raman pump in a cascaded EDF either after or before a DCF with that of a Raman-assisted EDFA in terms of gain, NF, nonlinearity, and BER.

Room 303C-D

OThG • Access Networks—Continued

OThG5 • 9:45 a.m.
Performance Evaluation of Optical CDMA Networks with Random Media Access Schemes, *Fei Xue, Zhi Ding, S. J. Ben Yoo; Univ. of California at Davis, USA.* This paper presents a performance analysis approach for OCDMA networks, which takes into account both the physical layer characteristics and random media access schemes. Analysis results demonstrate its effectiveness in characterizing the OCDMA network dynamics.

OThG6 • 10:00 a.m.
Terabit LAN with Optical Virtual Concatenation for Grid Applications with Super-Computers, *Masahito Tomizawa, Jun Yamawaku, Yoshihiro Takigawa, Masafumi Koga, Yutaka Miyamoto, Toshio Morioka, Kazuo Hagimoto; NTT Network Innovation Labs, Japan.* This paper proposes an optical LAN that can transmit Terabit-class bulk-data with low latency in a dynamic manner. Wavelength-group is assigned to bulk-data according to the latency requirement, and parallel-WDM signals are transmitted with bit-phase synchronization, after fast provisioning.

Room 304A-B

OThH • Performance Monitoring—Continued

OThH6 • 9:45 a.m.
Chromatic Dispersion Monitoring Using Time-Multiplexed In-Band RF Tones, *Andrew Liu, G. J. Pendock, Rodney S. Tucker; ARC Special Res. Ctr. for Ultra-Broadband Information Networks, Australia.* We demonstrate a simple low-cost dispersion monitoring technique using two time-multiplexed in-band RF tones. Compared to conventional monitoring techniques using a single RF tone, this technique improves the monitoring range and sensitivity without increasing the system complexity.

OThH7 • 10:00 a.m.
Chromatic Dispersion Measurement of SOA in C + L Band by Self-Tracking Real-Time Interferometry, *Kensuke Ogawa, Thi Thi Lay; Bussan Nanotech Res. Inst. (XNRI), Japan.* Chromatic dispersion in an SOA is characterized by high-accuracy broadband spectral interferometry. The chromatic dispersion is dominated by gain-induced frequency-dependent refractive index with a dispersion slope of 0.132 ps/nm^2 at 100-mA injection current.

Notes

10:00 a.m.–4:00 p.m. EXHIBIT HALL OPEN

OThB • Microwave Photonics—Continued

OThB5 • 10:15 a.m.
Microwave Frequency Upshifting Technique for Broadband Arbitrary Waveform Generation, *Jose Azana[1], Naum K. Berger[2], Boris Levit[2], Vladimir Smulakovsky[2], Baruch Fischer[2]; [1]Inst. Natl. de la Recherche Scientifique, Canada, [2]Technion - Israel Inst. of Technology, Israel.* A new microwave frequency upshifting technique based on a general temporal self-imaging effect in fiber is proposed and demonstrated. Experimental results evidence the drastic bandwidth improvement provided by this technique as compared with conventional solutions

10:30 a.m.–11:00 a.m. BEVERAGE BREAK, EXHIBIT HALL

Ballroom E

OThE • All-Optical Signal Processing II—Continued

OThE7 • 10:15 a.m.
Reduction of Nonlinear Patterning Effects in SOA-Based All-Optical Switches Using Optical Filtering, *Mads L. Nielsen*[1], *Jesper Moerk*[1], *Jun Skaguchi*[2], *Rei Suzuki*[2], *Yoshiyasu Ueno*[2]; [1]*Res. Ctr. COM, Denmark,* [2]*Graduate School of Electronic Engineering, Univ. of Electro-Communications, Japan.* We explain theoretically, and demonstrate and quantify experimentally, how appropriate filtering can reduce the dominant nonlinear patterning effect, which limits the performance of differential-mode SOA-based switches.

Room 303A-B

OThF • Raman Amplifiers—Continued

OThF7 • 10:15 a.m.
Raman Gain Efficiency Measured on 16 Mm of Raman Optimized NZDF Fiber, *Bera Palsdottir, C. Christian Larsen; OFS Fitel Denmark I/S, Denmark.* We present results for Raman gain efficiency, C_R, of a Raman optimized NZDF, measured on a large-scale production volume of 16,000 km. The average value of C_R is 0.60 $(W.km)^{-1}$ with 2.5% standard deviation.

Room 303C-D

OThG • Access Networks—Continued

OThG7 • 10:15 a.m.
Full-Duplex Wireless-over-Fibre Transmission Incorporating a CWDM Ring Architecture with Remote Millimetre-Wave LO Delivery Using a Bi-Directional SOA, *Tabassam Ismail*[1], *Chin-Pang Liu*[1], *John E. Mitchell*[1], *Alwyn J. Seeds*[1], *Xin Qian*[2], *Adrian Wonfor*[2], *Richard V. Penty*[2], *Ian H. White*[2]; [1]*Univ. College London, UK,* [2]*Univ. of Cambridge, UK.* We demonstrate the first full-duplex wireless-over-fibre transmission between a central station and a CWDM ring architecture with remote 40 GHz LO delivery using a bi-directional semiconductor optical amplifier.

Room 304A-B

OThH • Performance Monitoring—Continued

OThH8 • 10:15 a.m.
Low Cost Dispersion Sign Monitor for 40Gb/s Systems, *Mark Zaacks*[1], *Uri Mahlab*[1], *Moshe Horowitz*[2]; [1]*ECI Telecom, Israel,* [2]*Technion, Israel.* Precise control of tunable dispersion compensators requires dispersion sign monitoring. We demonstrate a novel low-cost per-channel dispersion sign monitor for non-linear and noise limited networks with bit-rates up to 40Gb/s.

10:30 a.m.–11:00 a.m. BEVERAGE BREAK, EXHIBIT HALL

Exhibit Hall D

Market Watch
10:30 a.m.–12:30 p.m.
Global Market Potential—R&D or Reality?

Moderator: *Serge Melle, Vice President, Network Architecture, Infinera Corp., USA*

Speakers:

- *Myo Ohn, Vice President, Marketing & Business Development, OpTun Inc., USA*
- *David Welch, Chief Development Officer, Infinera Corp., USA*
- *Scott Clavenna, Chief Analyst, Heavy Reading, USA*
- *Glenn Wellbrock, Director of Network Technology Development, MCI, USA*

(See page 13 for details.)

Ballroom A

11:00 a.m.–12:30 p.m.
OThI • Fiber Applications
Karl Koch; Corning Inc., USA, Presider

OThI1 • 11:00 a.m. Invited
Radiation Hard Optical Fibers, *Henning Henschel, Jochen Kuhnhenn, Udo Weinand; Fraunhofer-INT, Germany.* Meanwhile there exist fibers of nearly all types that show sufficient radiation hardness in lengths necessary for the respective application. Hydrogen loading or treatment and thermal or photo bleaching can harden certain fibers or fiber links.

Ballroom B

11:00 a.m.–12:15 p.m.
OThJ • Dispersion Equalization
Kim Roberts; Nortel Networks, Canada, Presider

OThJ1 • 11:00 a.m.
Adaptive Opto-Electronic Compensator for Excessive Filtering, Chromatic and Polarization Mode Dispersion, *Ut-Va Koc, Young-Kai Chen; Bell Labs, Lucent Technologies, USA.* We propose an opto-electronic equalizer combining optical and electronic equalizers optimized jointly by the novel opto-electronic least mean squares algorithm. Through simulation, we demonstrate that it can efficiently compensate GVD, PMD and excessive optical filtering.

OThJ2 • 11:15 a.m.
Electronic Dispersion Compensation by Signal Predistortion Using a Dual-Drive Mach-Zehnder Modulator, *Robert I. Killey[1], Phillip M. Watts[1], Vitaly Mikhailov[1], Madeleine Glick[2], Polina Bayvel[1]; [1]Univ. College London, UK, [2]Intel Res., UK.* We propose the technique of signal predistortion using a dual-drive Mach-Zehnder modulator and nonlinear digital filters, and demonstrate compensation of 13600ps/nm, equivalent to 800 km of standard single mode fibre, at 10Gb/s.

Ballroom C

11:00 a.m.–12:30 p.m.
OThK • Protection and Restoration
Paul Bonenfant; Mahi Networks, USA, Presider

OThK1 • 11:00 a.m. Tutorial
Recovery in Multilayer Optical Networks, *Piet Demeester, Mario Pickavet, Didier Colle; Univ. of Ghent, Belgium.* High availability is a key requirement of modern complex multilayer communication networks. This tutorial will explain the concepts of recovery mechanisms used in todays multilayer networks where a.o. IP, MPLS and optical technologies are combined.

Piet Demeester and Mario Pickavet are professors and Didier Colle is post-doc at the Ghent University-IBBT where they are involved in research on optical communication networks, including WDM, IP, (G-)MPLS, OPS, OBS and multilayer networks. One of the key problems investigated is the design of resilient (multilayer and multidomain) networks, which is the topic of this tutorial. They are involved in many European research projects and published over 300 journal or conference papers in this field. They have co-authored or contributored to the recent book "Network Recovery: Restoration and Protection of Optical, SONET-SDH, IP and MPLS" by Jean Philippe Vasseur, Mario Pickavet and Piet Demeester; Morgan Kaufmann, Elsevier, 2004.

Ballroom D

11:00 a.m.–12:30 p.m.
OThL • Erbium Amplifiers
Jeff Livas; Ciena Corp., USA, Presider

OThL1 • 11:00 a.m.
Effect of Erbium Ion Concentration on Gain Spectral Hole Burning in Silica-Based Erbium-Doped Fiber, *Shunsuke Ono[1], Setsuhisa Tanabe[1], Masato Nishihara[2], Etsuko Ishikawa[2]; [1]Graduate School of Human and Environmental Studies, Kyoto Univ., Japan, [2]Photonic Systems Lab, Network Systems Labs, Japan.* The erbium concentration dependence of gain spectral hole burning in EDF was investigated. We propose the energy transfer mechanism between Er ions, which contributes to the suppression of the second-hole at 1530 nm.

OThL2 • 11:15 a.m.
EDFAs with Improved Gain-Flatness Owing to a New Pump Design, *Philippe Bousselet[1], Christian Simonneau[1], Dominique Bayart[1], Paul Salet[2], Gaelle Lucas-Leclin[2], Gérard Roger[2], Patrick Georges[2], Sophie-Charlotte Auzanneau[3], Nicolas Michel[3], Michel Calligaro[3], Olivier Parillaud[3], Michel Lecomte[3], Michel Krakowski[3]; [1]Alcatel R&I, France, [2]IOTA, CNRS/Univ. Paris-Sud, France, [3]Thalès Res. and Technology, France.* A new pump source based on a semiconductor array coupled with an external cavity laser is shown. Its broad output spectrum allows to improve the EDFA gain flatness while reducing manufacturing cost.

Notes

Ballroom E

11:00 a.m.–12:30 p.m.
OThM • VCSELS
Yasaka Hiroshi; NTT Photonics Labs, Japan, Presider

OThM1 • 11:00 a.m. Invited
Long Wavelength VCSELs, *Markus C. Amann; Technical Univ. of Munich, Germany.* Single-mode AlGaInAs/InP VCSELs for the 1.4-2μm wavelength range with sub-mA threshold currents, <1V threshold voltage, >100°C cw operation, single-mode operation with SMSR of 50 dB and modulation bandwidth up to 10Gbit/s are presented.

Room 303A-B

11:00 a.m.–12:30 p.m.
OThN • Optical Subsystems
Reinhold Ludwig; Heinrich-Hertz-Institut, Germany, Presider

OThN1 • 11:00 a.m.
Novel Time Domain Add/Drop Multiplexer Based on Double-Pumped Four-Wave-Mixing and Cross-Phase-Modulation Induced Spectral Shift in a Semiconductor Optical Amplifier, *Claudio Porzi[1], Luca Poti[2], Antonella Bogoni[2]; [1]Scuola Superiore Sant'Anna, Italy, [2]CNIT, Italy.* Channel extraction and clearing for all-optical Add/Drop is demonstrated in a novel configuration exploiting both Four-Wave-Mixing and Cross-Phase-Modulation in a single Semiconductor Optical Amplifier. The scheme is insensitive to signal input polarization and wavelength.

OThN2 • 11:15 a.m.
Time Division Add-Drop Multiplexing up to 320 Gbit/s, *Colja Schubert[1], Carsten Schmidt-Langhorst[1], Karsten Schulze[2], Vincent Marembert[1], Hans-Georg Weber[1]; [1]Heinrich-Hertz-Inst. HHI-FhG, Germany, [2]Nanophotonics Technology Ctr., Univ. Politecnica, Spain.* We report an all-optical add-drop multiplexer based on a Kerr-gate comprising highly nonlinear fiber. Error-free operation is obtained for all channels at 160Gbit/s. The device can operate up to 320Gbit/s, which is demonstrated by eye diagram measurements.

Room 303C-D

11:00 a.m.–12:30 p.m.
OThO • PSK Systems
Rene-Jean Essiambre; Lucent Technologies, USA, Presider

OThO1 • 11:00 a.m.
Experimental Comparison of the RZ-DPSK and NRZ-DPSK Modulation Formats, *Jin-Xing Cai, Carl R. Davidson, Dmitri G. Foursa, Li Liu, Yi Cai, Bamdad Bakhshi, Georg Mohs, Will W. Patterson, Pat C. Corbett, Alan J. Lucero, Bill Anderson, Haifeng Li, Morten Nissov, Alexei N. Pilipetskii, Neal S. Bergano; Tyco Telecommunications, USA.* The RZ-DPSK and NRZ-DPSK modulation formats were experimentally compared using installed undersea fiber links. Our results show a 1-1.5 dB RZ benefit with optimized RZ modulation depth for both 25-GHz and 33-GHz spaced channels.

OThO2 • 11:15 a.m.
Experimental Comparisons of DPSK and OOK in Long Haul Transmission with 10Gbit/s Signals, DMF Span and Raman Assisted EDFA, *Takanori Inoue[1], Kazuyuki Ishida[2], Eiichi Shibano[1], Hidenori Taga[1], Katsuhiro Shimizu[2], Koji Goto[1], Kuniaki Motoshima[2]; [1]KDDI-SCS, Japan, [2]Mitsubishi Electric Corp., Japan.* We compare tolerance to SPM and XPM of CS-RZ DPSK signal and CS-RZ OOK signal experimentally. The advantage of DPSK could be maintained after 7,200km transmission using DMF spans of 150km and Raman assisted EDFAs.

Room 304A-B

11:00 a.m.–12:30 p.m.
OThP • Control Plane and IP/ Optical Integration
Olga Aparicio; Mitretek Systems, USA, Presider

OThP1 • 11:00 a.m. Invited
Progress in Distributed Control Plane Internetworking: An Update from the OIF, *Amy Wang; Avici, USA.* From today's network model to next generation IP optical network, this talk provides an industry update on the control plane technology, market adoption by vendor and carrier community, and the driving force for successful deployment and services.

Notes

Ballroom A

OThI • Fiber Applications—Continued

OThI2 • 11:30 a.m. Tutorial
Optical Coherence Tomography, *Zhongping Chen; Univ. of California at Irvine, USA.* Optical coherence tomography (OCT) is an emerging imaging technology that has found many clinical applications. Several key improvements in OCT technology resulted directly from advances in telecommunication field. This tutorial will review the principles of OCT and highlight recent advances.

Dr. Zhongping Chen is an Associate Professor of Biomedical Engineering and Director of OCT Laboratory at the University of California at Irvine. He received his B.S. in Applied Physics from Shanghai Jiaotong University in 1982, and a Ph.D. degree in Applied Physics from Cornell University in 1992.

Dr. Chen has made significant contributions to the fields of biomedical optical imaging. His group has pioneered the development of phase resolved functional optical coherence tomography, which simultaneously provides high resolution cross-sectional images of tissue structure, blood flow, and birefringence. Dr. Chen is also one of the leading researchers in the integration of micro-fabrication technology, optical technology, and biotechnology to develop diagnostic and therapeutic devices and instruments. He has published over 60 peer-reviewed papers and review articles and holds numerous patents in the fields of biomaterials, biosensors, and biomedical imaging.

Ballroom B

OThJ • Dispersion Equalization—Continued

OThJ3 • 11:30 a.m. Invited
Electronic Domain Compensation of Optical Dispersion, *John McNicol, M. O'Sullivan, K. Roberts, A. Comeau, D. McGhan, L. Strawczynski; Nortel Networks, Canada.* Recent advances in the electrical equalization of optical systems are presented in the context of standard methods. We report 10 Gb/s transmission over 60,000 ps/nm of optical dispersion from 3840 km of NDSF.

OThJ4 • 12:00 p.m.
Measurement of the Dispersion Tolerance of Optical Duobinary with an MLSE-Receiver at 10.7 Gb/s, *Joerg-Peter Elbers[1], Horst Wernz[1], Helmut Griesser[1], Christoph Glingener[1], Andreas Faerbert[2], Stefan Langenbach[2], Nebojsa Stojanovic[2], Claus Dorschky[2], Theo Kupfer[2], Christoph Schulien[2]; [1]Marconi Communications, Germany, [2]CoreOptics, Germany.* We experimentally demonstrate a significant improvement in the dispersion tolerance of optical duobinary modulation when employing an MLSE instead of a standard receiver. We show that the improvement critically depends on the MLSE design.

Ballroom C

OThK • Protection and Restoration—Continued

OThK2 • 12:00 p.m.
Exploiting Connection-Holding Time to Improve Resource Efficiency for Dynamic Provisioning in Shared-Path Protection, *Massimo Tornatore[1], Canhui (Sam) Ou[2], Achille Pattavina[1], Biswanath Mukherjee[3]; [1]Politecnico di Milano, Italy, [2]SBC Services Inc., USA, [3]Univ. of California at Davis, USA.* For dynamic provisioning of shared-path-protected connections in an optical mesh network, we investigate a new algorithm which exploits the holding time of connections to achieve significant reduction in resource overbuild.

Ballroom D

OThL • Erbium Amplifiers—Continued

OThL3 • 11:30 a.m.
Gain-Flatness Improvement over C-Band Employing Silica-Based Borate/Alumina-Codoped EDF, *Tetsuya Haruna[1], Motoki Kakui[1], Shinji Ishikawa[1], Tetsuya Mouri[2], Masato Ueno[2], Takahiro Murata[2], Kenji Morinaga[2]; [1]Sumitomo Electric Industries, Ltd., Japan, [2]Kyushu Univ., Japan.* Employing borate/alumina-codoped EDF, the relative gain ripple over the C-band has been reduced to less than 10%, which is to our knowledge the record for the gain flatness of C-band silica-based EDFAs.

OThL4 • 11:45 a.m.
DGE-Based Variable Gain EDFA Improves Both Gain Flatness and Noise Figure for a 70°C Temperature Operating Range, *Laurence Lolivier, Augustin Grillet, Fabien Roy, Dominique Hamoir; Multitel asbl, Belgium.* We designed a +17.5dBm variable-gain EDFA (20 to 28dB) incorporating a dynamic gain equalizer (DGE). Its noise figure is maintained below 5.2dB and its gain flatness better than 1dB when operating from -5 to +65°C.

OThL5 • 12:00 p.m.
Dynamic Gain-Fluctuations in Gain-Clamped EDFA in Packet Switched Optical Transmissions, *Djeisson H. Thomas, Jean Pierre Von der Weid; Pontifical Catholic Univ. of Rio de Janeiro, Brazil.* A ring laser gain-clamped erbium-doped fiber amplifier (EDFA) was used to study dynamic gain fluctuations induced by laser relaxation oscillations during optical packet collisions in an emulated packet switched WDM network.

Notes

Ballroom E

OThM • VCSELs—Continued

OThM2 • 11:30 a.m.
50 GHz Directly-Modulated Injection-Locked 1.55 μm VCSELs, *Lukas Chrostowski[1], Xiaoxue Zhao[1], Connie Chang-hasnain[1], Robert Shau[2], Markus Ortsiefer[2], Markus-Christian Amann[2]; [1]Univ. of California at Berkeley, USA, [2]VERTILAS GmbH, Germany.* The resonance frequency of several 1.55 μm VCSELs is enhanced from 7 GHz up to ~50 GHz with the optical injection locking technique. This is the highest value reported for directly modulated lasers.

OThM3 • 11:45 a.m.
All-Monolithic InAlGaAs/InP VCSELs for 1.3 ~ 1.5 um Wavelength Ranges, *Mi-Ran Park[1], O-Kyun Kwon[1], Won-Seok Han[1], Jong-Hee Kim[1], Sang-Hee Ko Park[1], Ki-Hwang Lee[2], Seong-Joo Park[2], Byueng-Su Yoo[2], Hyun-Woo Song[1]; [1]Basic Res. Lab, ETRI, Republic of Korea, [2]RayCan Co., Ltd., Republic of Korea.* All-monolithic InAlGaAs/InP VCSELs over 1.3~1.5 μm wavebands were successfully demonstrated. Single mode power of ~ 1 mW and modulation bandwidth exceeding 2.5 Gbps at room temperature and CW operation over 80°C were obtained in both 1.3 and 1.5 μm.

OThM4 • 12:00 p.m.
1325 nm VCSELs Emitting 1.2 mW Single Mode Output in the 20-80° C Temperature Range, *Alexei Sirbu[1], Alexandru Mereuta[1], Andrei Caliman[1], Vladimir Iakovlev[1], Claude-Albert Berseth[1], Grigore Suruceanu[1], Eli Kapon[1,2], Alok Rudra[2]; [1]BeamExpress S.A., Switzerland, [2]Swiss Fed. Inst. of Technology, EPFL, Switzerland.* Wafer-fused InGaAlAs/AlGaAs VCSELs emitting in the vicinity of 1325 nm with InAlGaAs-based tunnel junction injection show record high 1.2 mW single mode output and 40 dB side-mode suppression ratio in the 20-80° C temperature range and good on-wafer device parameters uniformity.

Room 303A-B

OThN • Optical Subsystems—Continued

OThN3 • 11:30 a.m.
All-Optical Analog-to-Digital Conversion by Slicing Supercontinuum Spectrum and Switching with Nonlinear Optical Loop Mirror, *Sho-ichiro Oda, Akihiro Maruta; Graduate School of Engineering, Osaka Univ., Japan.* We propose a novel all-optical analog-to-digital conversion scheme consisting of the quantization by slicing supercontinuum spectrum and the coding by switching pulses with a nonlinear optical loop mirror. The proposed scheme is experimentally demonstrated.

OThN4 • 11:45 a.m.
Frequency Multiplexing Technique for Relative-Intensity-Noise Reduction, *Noritaka Taguchi[1], Shingto Tanaka[1], Tsuneto Kimura[2], Yasunori Atsumi[1]; [1]Optowave Lab Inc., Japan, [2]Yazaki Corp., Japan.* A 10dB relative-intensity-noise reduction is achieved by a novel scheme that multiplexes local-oscillation frequency and intermediate frequencies. Simulations conducted to evaluate relative-intensity-noise levels well match the experimentally obtained data.

OThN5 • 12:00 p.m. Invited
Advances in Planar Lightwave Circuits, *David Dougherty; JDS Uniphase, USA.* Advances in silica-on-silicon Planar Lightwave Circuit (PLC) technology are enabling a higher level of integration for Reconfigurable Add/Drop Multiplexers. Newer integrated optics materials systems offer important advantages in cost and performance.

Room 303C-D

OThO • PSK Systems—Continued

OThO3 • 11:30 a.m. Invited
Nonlinear Phase Noise in Phase-Coded Transmission, *Hoon Kim[1], Peter J. Winzer[2]; [1]Samsung Electronics, Republic of Korea, [2]Bell Labs, Lucent Technologies, USA.* We review nonlinear phase noise in phase-coded transmission systems, emphasizing experimental results. We describe measurements of nonlinear phase noise as well as its impact on 10-Gbps and 40-Gbps transmission systems.

OThO4 • 12:00 p.m.
Impact of RZ Pulse Carver Phase Errors on Optical DQPSK, *Yan Han, Guifang Li; Univ. of Central Florida, USA.* The impact of phase errors caused by imperfect return-to-zero (RZ) pulse carving on optical differential quadrature phase-shift keying (DQPSK) is analyzed. The two-symbol-delayed interferometric demodulation is proposed as an effective means to mitigate this degradation.

Room 304A-B

OThP • Control Plane and IP/Optical Integration—Continued

OThP2 • 11:30 a.m.
Peer/Overlay Hybrid Optical Network Using Protocol Gateways of GMPLS and OIF-UNI/NNI, *Michiaki Hayashi[1], Kenichi Ogaki[1], Tomohiro Otani[1], Hideaki Tanaka[1], Tomoshige Funasaki[2], Hiroyuki Tanuma[2]; [1]KDDI R&D Labs Inc., Japan, [2]NEC Corp., Japan.* Peer/overlay hybrid optical networks with protocol gateways of GMPLS and OIF-UNI/NNI were demonstrated for the first time. UNI connections were successfully established over a single TDM/photonic GMPLS domain as well as OIF E-NNI-based multiple domains.

OThP3 • 11:45 a.m.
Field Trial of 40-Gbit/s Wavelength Path Quality Assurance Using GMPLS-Controlled All-Optical 2R Regenerator, *Mikio Yagi[1], Shinya Tanaka[1], Shuichi Satomi[1], Shiro Ryu[1], Koji Okamura[2], Mutsumi Aoyagi[3], Shoichiro Asano[3]; [1]Japan Telecom Co., Ltd., Japan, [2]Kyushu Univ., Japan, [3]Natl. Inst. of Informatics, Japan.* We have successfully demonstrated a field trial of 40-Gbit/s wavelength path quality assurance by applying a GMPLS-controlled all-optical 2R regenerator that is incorporated in multilayer integration system among GMPLS control, measurement, and data planes.

OThP4 • 12:00 p.m. Invited
IP/Optical Integration, *Rajiv Papneja; Isocore, USA.* Abstract not available.

Notes

OThK • Protection and Restoration—Continued

OThK3 • 12:15 p.m.
A Different Time Delay Technique for Supervising Switch Fabric in OXC, *Chien-Chung Lee[1], Ta-Chun Kao[1], Hung-Chang Chien[1], Kai-Ming Feng[2], Sien Chi[3]; [1]Natl. Chiao-Tung Univ., Taiwan Republic of China, [2]Natl. Tsing-Hua Univ., Taiwan Republic of China, [3]Yuan Ze Univ., Taiwan Republic of China.* A novel supervising technique, based on different time-delay recognition scheme, to monitor the switch fabric of optical cross-connect (OXC) is proposed. This method features fast detection, high reliability, and switch fault location.

OThL • Erbium Amplifiers—Continued

OThL6 • 12:15 p.m.
Erbium Doped Waveguide Amplifiers (EDWAs) Fabricated in Novel Bulk Glasses Using Femtosecond Pulses, *Robert R. Thomson[1], Henry T. Bookey[1], Stuart Campbell[1], Derryck T. Reid[1], Ajoy K. Kar[1], Shaoxiong X. Shen[2], Animesh Jha[2]; [1]Heriot Watt Univ., UK, [2]Inst. for Materials Res., Univ. of Leeds, UK.* We present the results of optical characterisation experiments conducted on Erbium Doped Waveguide Amplifiers (EDWAs) fabricated in novel erbium doped bulk glasses using femtosecond pulses to modify the refractive index of the glass.

12:30 p.m.–1:30 p.m. LUNCH BREAK (On Your Own)

1:30 p.m.–3:30 p.m.
OThQ • Grating Devices and Poling
Raman Kashyap; Ecole Polytechnique de Montreal, Canada, Presider

OThQ1 • 1:30 p.m. Invited
Progress on Fibre Poling and Devices, *Walter Margulis, Niklas Myrén; ACREO, Sweden.* One can induce second-order nonlinearity in fibers through poling. Electrooptical modulation, switching and wavelength conversion can thus be achieved. We describe accomplishments of the EU project GLAMOROUS in creating low-cost high performance electrooptic fiber components.

1:30 p.m.–3:30 p.m.
OThR • Optical Transmission Systems
Rongqing Hui; Univ. of Kansas, USA, Presider

OThR1 • 1:30 p.m.
Optical Pulse Generator Using Phase Modulator and Chirped Bragg Grating, *Tetsuro Komukai, Takashi Yamamoto, Satoki Kawanishi; NTT Corp., Japan.* We demonstrate an optical pulse generator, in which CW light is modulated by a phase modulator and compressed into pulses by linearly chirped fiber Bragg gratings. Two types of pulse are generated by changing the conditions.

1:30 p.m.–3:30 p.m.
OThS • Network Design II
Ori A. Gerstel; Network Architecture Consultant, USA, Presider

OThS1 • 1:30 p.m. Invited
Past, Present and Future of Customer-Owned Optical Networks, *Bill St. Arnaud; Canarie Inc., Canada.* A technical and business case overview of customer owned fiber and wavelength networks is provided along with a perspective of new hardware and network management systems that will further enable lower cost deployment of such systems in the future.

1:30 p.m.–3:30 p.m.
OThT • PMD: Modeling and Monitoring
Misha Boroditsky; AT&T Labs, USA, Presider

OThT1 • 1:30 p.m.
Novel First and Second Order Polarization Mode Dispersion Emulator, *Yannick Keith Lizé[1], Leigh Palmer[2], Pierre Jr Lavoie[1], Nicolas Godbout[1], Suzanne Lacroix[1], Raman Kashyap[1]; [1]École Polytechnique de Montréal, Canada, [2]Univ. of Melbourne, Australia.* A novel, simple and low-cost PMD emulator design is demonstrated in which the multiple polarization scrambling stages are replaced by a single, customized polarization controller. Simulation and experiment confirm that first and second order statistics are accurately emulated.

Ballroom E

OThM • VCSELS—Continued

OThM5 • 12:15 p.m.
Impedance-Detuned High-Contrast Vertical Cavity Semiconductor Switch, *Claudio Porzi[1,2], Antti Isomaki[1], Mircea Guina[1], Oleg G. Okhotnikov[1]; [1]Tampere Univ. of Technology, Finland, [2]Scuola Superiore Sant'Anna, Italy.* We report an all-optical semiconductor gate optimized for high-contrast switching. Using a pump signal with an intensity of less than ~25 KW/cm2, we demonstrate a 30-dB contrast ratio for 10-GHz pulses with energy of 0.05 pJ.

Room 303A-B

Room 303C-D

OThO • PSK Systems—Continued

OThO5 • 12:15 p.m.
Reduction of Nonlinear Phase Noise by Mid-Link Spectral Inversion in a DPSK Based Transmission System, *Sander L. Jansen[1], Dirk van den Borne[1], Giok-Djan Khoe[1], Huug de Waardt[1], Carlos Climent Monsalve[2], Stefan Spälter[3], Peter M. Krummrich[3]; [1]COBRA Inst., Eindhoven Univ. of Technology, Netherlands, [2]Polytechnic Univ. of Madrid, Spain, [3]Siemens AG, ICN Carrier Products, Netherlands.* We show in an 800km SSMF transmission experiment, that mid-link spectral inversion can be employed to reduce the effect of nonlinear phase noise (Gordon-Mollenauer noise) on DPSK by over two decades in BER.

Room 304A-B

Exhibit Hall D

12:30 p.m.–1:30 p.m. LUNCH BREAK (On Your Own)

Ballroom E

1:30 p.m.–3:30 p.m.
OThU • Low Cost Lasers and Packaging
Kirk S. Giboney; Agilent Technologies Inc., USA, Presider

OThU1 • 1:30 p.m.
Highly Reliable AlGaInAs Buried Heterostructure Lasers for Uncooled 10Gb/s Direct Modulation, *Nobuyuki Ikoma, Takahiko Kawahara, Noriaki Kaida, Michio Murata, Akihiro Moto, Takashi Nakabayashi; Sumitomo Electric Industries, Ltd., Japan.* High reliability (estimated median lifetime of 240,000hours) of 1.3μm AlGaInAs buried heterostructure lasers has been demonstrated by more than 10,000 hours accelerated aging tests. Distributed-feedback lasers have successfully operated at 10Gb/s at 95° C.

Room 303A-B

1:30 p.m.–3:30 p.m.
OThV • Planar Lightwave Circuits
Haifeng Li; Tyco Telecommunications, USA, Presider

OThV1 • 1:30 p.m.
Three-Dimensional Waveguide Interconnection Formed with Femtosecond Laser in Planar Lightwave Circuits, *Yusuke Nasu, Masaki Kohtoku, Yoshinori Hibino, Yasuyuki Inoue; NTT Corp., Japan.* The 3-D interconnection of waveguides in the planar lightwave circuits (PLCs) is demonstrated for the first time. By writing 3-D waveguides that cross other waveguides, the femtosecond laser successfully interconnects PLC waveguides with low loss.

Room 303C-D

1:30 p.m.–3:15 p.m.
OThW • FEC and Line Coding
Takashi Mizuochi; Mitsubishi Electric Corp., Japan, Presider

OThW1 • 1:30 p.m.
Channel Capacity of Fiberoptic Communication Systems with Amplified Spontaneous Emission Noise, *Yi Cai, Alexei N. Pilipetskii; Tyco Telecommunications, USA.* We evaluate the capacity of fiberoptic channels dominated by linear amplified spontaneous emission noise for different modulation formats. Based on the channel capacities we discuss possible gains from different modulation and coding techniques.

Room 304A-B

1:30 p.m.–3:30 p.m.
OThX • Measurements and Performance Monitoring
Martin Birk; AT&T, USA, Presider

OThX1 • 1:30 p.m. Tutorial
Network Cost Impact of Solutions for Mitigating Optical Impairments: Comparison of Methods Techniques, and Practical Deployment Constraints, *Michel Belanger; Nortel, Canada.* The network costs of dispersion compensation strategies are reviewed. Practical field issues such as PMD, non-uniform span loss distributions and OADM placement are considered. The performance and cost impact of electrical and optical methods are compared.

Michel P. Belanger obtained his Ph.D. in Electrical Engineering (guided wave optics) from McGill University in Montreal in 1987. He held R&D positions at Ecole Polytechnique in Montreal and at Canadian Marconi. With the National Optics Institute of Canada, he conducted research

Exhibit Hall D

Market Watch
1:30 p.m.–3:30 p.m.
Ethernet Services—Catching on like Wild Fire?

Moderator: *Gary Southwell, Vice President Product Marketing, Ciena Corp., USA*

Speakers:

- *Brian Van Steen, Senior Analyst, RHK, USA*
- *John Hawkins, Senior Marketing Manager, Nortel Networks, USA*
- *Sunil Khandekar, Director of Project Management, Alcatel, USA*
- *Gary Southwell, Vice President Product Marketing, Ciena Corp., USA*

(See page 14 for details.)

Ballroom A

OThQ • Grating Devices and Poling—Continued

OThQ2 • 2:00 p.m.
Tuneable Second Harmonic Generation in Periodically Poled Optical Fibres, *Albert Canagasabey, Costantino Corbari, Mohd R. Mokhtar, Peter G. Kazansky, Morten Ibsen; Univ. of Southampton, UK.* A widely tuneable second harmonic generator in a periodically poled germanosilicate optical fibre is demonstrated for the first time. Broadband wavelength tuning of 27.8nm is achieved using a highly efficient compression tuneable package demonstrated with fibre Bragg gratings.

OThQ3 • 2:15 p.m.
Alkali Impurities and the Long-Wavelength Hydrogen-Induced Aging Loss in Ge-Doped Silica Fibers, *Kai H. Chang; OFS, USA.* Significant hydrogen aging loss in the long-wavelengths (>1360 nm) caused by alkali impurities (Na, Li and K) at ppma levels in Ge-doped silica fibers and its relevance to long-term reliability are discussed.

Ballroom B

OThR • Optical Transmission Systems—Continued

OThR2 • 1:45 p.m.
Photodetector Linearization Using Adaptive Electronic Postdistortion, *Juthika Basak, Bahram Jalali; Univ. of California at Los Angeles, USA.* Photodetector linearization using a monolithic CMOS polynomial generator is demonstrated. Improvements of 32.5 dB and 7.2 dB are demonstrated for the 2nd order and the 3rd order Input Intercept Point, respectively.

OThR3 • 2:00 p.m. Invited
Enabling 160Gbit/s Transmitter and Receiver Designs, *Lothar Moeller, Sr.[1], Yikai Su[2], Chongjin Xie[1], Roland Ryf[1], Xiang Liu[1], Xing Wei[1], Christopher R. Doerr[1]; [1]Bell Labs, Lucent Technologies, USA, [2]Shanghai Jiao Tong Univ., China.* The field of ultra high-speed (≥ 160Gb/s) transmission has developed rapidly over the past years from proof-of-principle demonstrations towards advanced field trial applications. We review recent trends in 160Gb/s signal generation and detection techniques.

Ballroom C

OThS • Network Design II—Continued

OThS2 • 2:00 p.m.
Delay Distributed VCAT for Efficient Data-Optical Transport, *Mansoor Alicherry, Chitra Phadke, Vishy Poosala; Lucent Technologies, USA.* We introduce a novel scheme that flexibly distributes the differential delays in virtual concatenation (VCAT) paths in SONET/SDH networks. We show that this increases the utilization of the network in carrying dynamic traffic and reduces the total buffer requirements.

OThS3 • 2:15 p.m.
Capacity Planning of Survivable Wavelength-Routed Networks for Increase of Traffic Loads, *Jintae Yu[1], Ikuo Yamashita[2], Shigeyuki Seikai[2], Ken-ichi Kitayama[1]; [1]Dept. of Electronics and Information Systems, Osaka Univ., Japan, [2]The Kansai Electric Power Co. Inc., Japan.* We propose a cost-effective capacity planning of survivable wavelength-routed networks optimized for initial traffic loads to study the effect of additional network costs corresponding to the increase in traffic demands with shared-path protection.

Ballroom D

OThT • PMD: Modeling and Monitoring—Continued

OThT2 • 1:45 p.m.
Maximum Second Order PMD in Emulators—A Geometric Approach, *Magnus Karlsson; Chalmers Univ. of Technology, Sweden.* A new geometric interpretation of second order PMD (SOPMD) is used to solve the problem of how the birefringent elements in an emulator should be oriented to maximize the SOPMD. Both depolarization and polarization-dependent chromatic dispersion will be considered.

OThT3 • 2:00 p.m.
Design and Optimization of Polarization Mode Dispersion Emulators for Low Background Autocorrelation, *Leigh Palmer, Sarah D. Dods, Peter M. Farrell; Univ. of Melbourne, Australia.* We show that the frequency correlation of multi-section PMD emulators can be minimized for any given set of birefringent elements. We present a model describing the underlying cause of the correlation, which is verified using simulations.

OThT4 • 2:15 p.m.
Fiber Transmission System Application and Limitation of Multicanonical Sampling in PMD Emulation, *Lianshan Yan[1], Tao Lu[2], Bo Zhang[1], Changyuan Yu[1], David Yevick[2], Alan Willner[1]; [1]Univ. of Southern California, USA, [2]Univ. of Waterloo, Canada.* We apply multicanonical sampling to a 10-Gb/s fiber transmission system using a recirculating loop as a PMD emulator. With 22-ps average PMD, the probability density at 10^{-5} BER increases from 5×10^{-4} (Monte-Carlo) to 0.01 (multicanonical).

Notes

Ballroom E

OThU • Low Cost Lasers and Packaging—Continued

OThU2 • 1:45 p.m.
Wide Temperature (-40°C~95°C) Operation of Uncooled 1610 nm DFB Laser for CWDM Application, *Atsushi Matsumura, Takeshi Kishi, Michio Murata, Takashi Kato; Sumitomo Electric Industries, Ltd., Japan.* We demonstrated a wide temperature operation from -40° C to 95° C of an L-band DFB laser for the first time. The BER at 2.5 Gb/s was maintained without error floor over 120 km up to 95° C.

OThU3 • 2:00 p.m.
Isolator-Free Directly Modulated Complex-Coupled DFB Lasers for Low Cost Applications, *Jochen Kreissl, Walter Brinker, Erika Lenz, Tom Gaertner, Wolfgang Rehbein, Stefan Bauer, Bernd Sartorius; Fraunhofer Inst., Germany.* Complex-coupled and index-coupled DFB lasers are fabricated and characterized regarding their feedback sensitivity. The feedback stability is improved by 15 dB using the complex coupling. BER measurements demonstrate the potential for isolator-free transmitter application

OThU4 • 2:15 p.m.
1V Operation Laser Diode for FTTH by Using Active Multi-Mode-Interferometer (MMI), *Kiichi Hamamoto[1], Masaki Ohya[1], Koichi Naniwae[1], Shinya Sudo[1], Tatsuya Sasaki[1], Syougo Shimizu[2], Mohd Dannial Bin Razali[2], Kenichi Kasahara[2]; [1]System Devices Res. Labs, NEC Corp., Japan, [2]Ritsumeikan Univ., Japan.* Active multi-mode-interferometer (MMI) laser diodes (LDs) achieved low operation voltage of only 1V at 10mW light output (Wavelength=1.5um), due to the significant resistance reduction of 60% compared to that of regular LDs, and 1Gbps operation.

Room 303A-B

OThV • Planar Lightwave Circuits—Continued

OThV2 • 1:45 p.m.
Fabrication of Wavelength Splitter Designed by Wavefront Matching Method, *Takashi Saida, Toshikazu Hashimoto, Ikuo Ogawa, Masaki Kohtoku, Tomohiro Shibata, Hiroshi Takahashi, Senichi Suzuki; NTT Corp., Japan.* We report the first fabrication of a waveguide device designed using our recently proposed wavefront matching method. We fabricated a very compact wavelength splitter having mosaic-like patterns, and confirmed its operation in experiments.

OThV3 • 2:00 p.m. Invited
Design of Waveguide Grating Routers for Simultaneous Multiple Optical Code Generation in Photonic MPLS Networks, *Gabriella Cincotti[1], Naoya Wada[2], Ken-ichi Kitayama[3]; [1]Univ. of Roma TRE, Italy, [2]Natl. Inst. of Information and Communication Technology of Japan, Japan, [3]Osaka Univ., Japan.* We review novel methods to generate optical codes for use in MPLS or CDM transmission. A standard WGR can be designed to generate simultaneously a large number of highly orthogonal codes as a result of a single input pulse.

Room 303C-D

OThW • FEC and Line Coding—Continued

OThW2 • 1:45 p.m.
A Ternary Modulation Code for Suppression of Intrachannel Nonlinear Effects in High-Speed Optical Transmission, *Ivan B. Djordjevic, Bane Vasic; Univ. of Arizona, USA.* In this paper, a novel approach in suppressing the intrachannel nonlinear effects based on ternary modulation codes is proposed. Significant Q-factor improvement, ranging from 4.5 to 7 dB (depending on number of spans) is obtained.

OThW3 • 2:00 p.m.
Net Coding Gain of 10.2 dB Using an Irregular LDPC Code with a Three-Dimensional Analyser, *Stefan Schoellmann, Oren Jean, Werner Rosenkranz; Univ. of Kiel, Germany.* We present a three-dimensional decoding scheme for an irregular Low Densitiy Parity Check Code (LDPC). With this setup, we achieved a Net Coding Gain of 10.2dB and a significant improvement in the iterating decoding process.

OThW4 • 2:15 p.m.
Improvement of DPSK Transmission by Using Convolutional Error Correction Coding, *Torsten Wuth, Erik Agrell, Magnus Karlsson; Chalmers Univ. of Technology, Sweden.* In this paper we quantify the improvement in the transmission quality for DPSK transmission by using convolutional error correction coding. To avoid bandwidth-limitation problems from e.g. chromatic dispersion the convolutional coding is combined with bandwidth efficient modulation.

Room 304A-B

OThX • Measurements and Performance Monitoring—Continued

into the fabrication and application of guided wave optical components for sensors and communication. After a stint with Teleglobe, in 1995 he joined Nortel Networks as product manager for DWDM systems. Later, he moved to the optical development group as a member of scientific staff. His current activity is the development of electro-optic engines for optical transmission systems.

Notes

Ballroom A

OThQ • Grating Devices and Poling—Continued

OThQ4 • 2:30 p.m.
Enhanced Supercontinuum Generation Near Fiber Bragg Resonances, *P. S. Westbrook[1], J. W. Nicholson[1], K. S. Feder[1], Y. Li[2], T. G. Brown[2]; [1]OFS Labs, USA, [2]Univ. of Rochester, USA.* We show that supercontinuum generation in a nonlinear fiber containing a Bragg grating is greatly modified near the Bragg resonance. We demonstrate enhancement of more than 10x in fibers with single and multiple grating resonances.

OThQ5 • 2:45 p.m.
Refractive Index Modulation in Photonic Crystal Fibers Induced by Mechanical Stress Relaxation Based on CO_2 Laser Irradiation, *Yinian Zhu, Ping Shum, Hui-Wen Bay, Min Yan, Xia Yu, Chao Lu; Network Technology Res. Ctr., Nanyang Technological Univ., Singapore.* Refractive index modulation in endlessly-single-mode photonic crystal fiber by CO_2 laser irradiation without surface-deformation is experimentally confirmed with a value of 1.68×10^{-3} for the first time, which is contributed by mechanical stress relaxation in fiber.

Ballroom B

OThR • Optical Transmission Systems—Continued

OThR4 • 2:30 p.m.
Achievement of 1 bit/s/Hz Information Spectral Density Using Coherent WDM, *Andrew D. Ellis, Fatima C. Garcia Gunning; Univ. College Cork, Ireland.* Coherent WDM—a new technique for high-spectral density—is proposed and demonstrated. Transmission of 42.66Gbit/s NRZ binary data channels at 1bit/s/Hz is achieved in a single polarisation using a WDM comb source with phase control.

OThR5 • 2:45 p.m.
160-GHz Pulse Generator Using a 40-GHz Phase Modulator and PM Fiber, *Changyuan Yu, Z. Pan, T. Luo, S. Kumar, L. S. Yan, B. Zhang, L. Zhang, Y. Wang, M. Adler, A. E. Willner; Univ. of Southern California, USA.* We demonstrate chirp-free CS-RZ pulse generation with a repetition rate of 160 GHz using a phase modulator driven by a 40 GHz clock and two low-cost polarization-maintaining fibers. The unwanted low frequency tones are suppressed by more than 15 dB.

Ballroom C

OThS • Network Design II—Continued

OThS4 • 2:30 p.m.
Investigation of the Tolerance of Wavelength-Routed Optical Networks to Inaccuracy in Traffic Load Forecasts, *Roger N. Lao[1], Robert Friskney[2], Robert Killey[1]; [1]Univ. College London, UK, [2]Nortel Networks, Harlow Labs, UK.* We carried out extensive computer simulations of wavelength-routed optical networks, identifying features of network topology that allow high tolerance to traffic forecast inaccuracy. The findings can be used to simplify the network design process.

OThS5 • 2:45 p.m.
Packet Error Rate and Bit Error Rate Non-Deterministic Relationship in Optical Network Applications, *Laura B. James[1], Andrew W. Moore[1], Adrian Wonfor[1], Richard Plumb[1], Ian H. White[1], Richard V. Penty[1], Madeleine Glick[2], Derek McAuley[2]; [1]Univ. of Cambridge, UK, [2]Intel Res. Cambridge, UK.* The non-deterministic relationship between Bit Error Rate and Packet Error Rate is demonstrated for an optical media access layer in common use. We show that frequency components of coded, non-random data can cause this relationship.

Ballroom D

OThT • PMD: Modeling and Monitoring—Continued

OThT5 • 2:30 p.m. Invited
Characterization and Measurement of the Polarization Properties of Optical Systems in the Presence of PMD and PDL, *Avishay Eyal, Moshe Tur; Tel Aviv Univ., Israel.* Techniques for measuring and characterizing the polarization properties of optical systems in the presence of PMD and PDL are described, as well as methods for extraction of various physical parameters from the experimental data.

Notes

Ballroom E

OThU • Low Cost Lasers and Packaging—Continued

OThU5 • 2:30 p.m.
Single-Mode-Fiber Direct Coupled 10-Gbps VCSEL-TOSA on Flexible Substrate Platform, *Masaaki Nido, Hiroshi Hatakeyama, Kazunori Miyoshi; NEC Corp., Japan.* New-type 10-Gbps VCSEL-TOSA was demonstrated with single-mode-fiber direct coupling optics and flexible substrate platform. The TOSA showed high fiber coupling efficiency (-1.6dB) and clear 10-Gbps eye-opening with -2.6dBm average optical power and 6dB extinction ratio.

OThU6 • 2:45 p.m.
Novel Packaging of Parallel-Optical Interconnects for High-End Servers, *Steven A. Rosenau[1], Jonathan Simon[2], Lisa A. Buckman Windover[1], Benjamin Law[1], Graham M. Flower[1], Edwin DeGroot[1], Annette Grot[1], Michael J. Nystrom[1], Chao-Kun Lin[1], Ashish Tandon[1], Kostadin Djordjev[1], Michael R. Tan[1], Laura W. Mirkarimi[1], Russell W. Gruhlke[1], Hui Xia[1], Glenn Rankin[1], Mohammed E. Ali[1], Brian E. Lemoff[1], Kirk S. Giboney[1], David W. Dolfi[1], Evan G. Colgan[3], Bruce Furman[3], John Magerlein[3], Jeremy Schaub[3], Dan Stigliani, Jr.[3]; [1]Agilent Technologies, USA, [2]Dust, Inc., USA, [3]IBM Corp., USA.* A novel packaging concept is demonstrated where parallel-optical subassemblies are mounted on the same substrate as processor chips for processor-to-processor communication within a high-end server. A single-channel bit-error ratio <1.5x10-15 was measured at 8 Gb/s.

Room 303A-B

OThV • Planar Lightwave Circuits—Continued

OThV4 • 2:30 p.m.
Compact and Low Power Consumption 16 x 16 Optical Matrix Switch with Silica-Based PLC Technology, *Shunichi Sohma, Toshio Watanabe, Tomohiro Shibata, Hiroshi Takahashi; NTT Photonics Labs, Japan.* We employed 1.5%Δ silica-based waveguides, heat insulating grooves and a new circuit layout for the first time to realize a 16x16 matrix switch and reduced both the chip size and the power consumption to one third the formerly reported values.

OThV5 • 2:45 p.m.
MZI Based 8-Channel Wideband WDM Filter Array with Low Loss Ripple and High Isolation Using Silica-Based PLC, *Kazutaka Nara, Haruki Urabe, Junich Hasegawa, Noritaka Matsubara, Hiroshi Kawashima; The Furukawa Electric Co., Ltd., Japan.* We demonstrated a novel MZI based 8-channel WDM filter array with a low loss ripple and a high isolation for B-PON system and obtained loss ripple <0.77dB, isolation >32dB for all pass-bands and all channels.

Room 303C-D

OThW • FEC and Line Coding—Continued

OThW5 • 2:30 p.m. Invited
Implications of Nonlinear Interaction of Signal and Noise in Low-OSNR Transmission Systems with FEC, *Alberto Bononi[1], Paolo Serena[1], Jean Christophe Antona[2], Sébastien Bigo[2]; [1]Parma, Italy, [2]Alcatel R&I, France.* We review the performance degradation due to noise parametric gain in long-haul single-channel NRZ terrestrial systems working at low OSNR and its implications on system design in the presence of forward error correction.

Room 304A-B

OThX • Measurements and Performance Monitoring—Continued

OThX2 • 2:30 p.m.
A Simple and Low-Cost 1625 nm OTDR Monitoring System for 350 km WDM Networks, *Han Hyub Lee[1], Yun Ho Nam[1], Donghan Lee[1], Hee Sang Chung[2], Kwangjoon Kim[2]; [1]Chungnam Natl. Univ., Republic of Korea, [2]Electronics and Telecommunication Res. Inst., Republic of Korea.* An SOA-based 1625nm OTDR monitoring system in a bypass configuration is successfully demonstrated for a 350km WDM network. No power penalty is observed in the 10Gb/s WDM transmissions when the OTDR signal is on.

OThX3 • 2:45 p.m.
Variation of PMD-Induced Outage Rates and Durations with Link Length on Buried Standard Single-Mode Fibers, *Pradeep K. Kondamuri[1], Christopher Allen[1], Douglas L. Richards[2]; [1]Univ. of Kansas/ITTC, USA, [2]Sprint Corp., USA.* From first-order polarization-mode dispersion (PMD) outage analysis using measured differential group delay (DGD) data on buried standard single-mode fibers, we observed that the outage rates increase monotonically with link length, although not linearly.

Notes

Ballroom A

OThQ • Grating Devices and Poling—Continued

OThQ6 • 3:00 p.m.
Sensing Characteristics of Long-Period Fiber Gratings in Photonic Crystal Fiber Imprinted by CO_2 Laser, *ByungHyuk Park, Jinchae Kim, Tae Joong Eom, Byeong Ha Lee, Un-Chul Paek; Gwangju Inst. of Science and Technology, Republic of Korea.* A long period fiber grating imprinted in a pure-silica PCF by using CO_2 laser beams is presented. The sensitivities of the resonant wavelength under bending, strain, and temperature were measured to be +16.4 nm-m, -0.95 pm/microstrain, and +9 pm/°C, respectively.

OThQ7 • 3:15 p.m.
Dynamics of Fiber Fuse Propagation, *Igor A. Bufetov[1], Artem A. Frolov[2], Evgeny M. Dianov[1], Vladimir E. Fortov[2], Vladimir P. Efremov[2]; [1]Fiber Optics Res. Ctr., Russian Federation, [2]Inst. for High Energy Density, Russian Federation.* Dynamics of fiber fuse effect including process of bubble formation in fiber core was investigated for the first time. Bubbles in the core were observed not later than 20-70 microseconds after passing of a plasma leading edge.

Ballroom B

OThR • Optical Transmission Systems—Continued

OThR6 • 3:00 p.m.
Effects of Dispersion, PMD and PDL on the Intensity Noise Suppression of Spectrum-Sliced Incoherent Light Sources Using Semiconductor Optical Amplifiers, *Hoon Kim, Sangho Kim, Seongtaek Hwang, Yunje Oh; Samsung Electronics, Republic of Korea.* We show through experiment that the intensity noise suppression of spectrum-sliced incoherent light sources achieved by using gain-saturated semiconductor optical amplifiers can be negated by chromatic dispersion, polarization-mode dispersion, or polarization-dependent loss.

OThR7 • 3:15 p.m.
PSK Homodyne Detection Using a Pilot Carrier for Multi-Bit/Symbol Transmission with Inverse-RZ Signal, *Tetsuya Miyazaki, Fumito Kubota; Natl. Inst. of Information and Communications Technology, Japan.* PSK-homodyne detection using a polarization-multiplexed pilot-carrier in 2-bit/symbol transmission with an inverse-RZ signal at 20 Gb/s was demonstrated. The proposed scheme allows a high-extinction-ratio inverse-RZ signal by intensity-noise reduction (>15 dB) in a homodyne-balanced receiver.

Ballroom C

OThS • Network Design II—Continued

OThS6 • 3:00 p.m. Invited
Service-Driven Networks for Packet-Aware Transport, *Robert Doverspike, K. K. Ramakrishnan, John Wei, Jorge Pastor, Chuck Kalmanek; AT&T Labs Res., USA.* This paper presents the Packet-Aware Transport Network (PATN). We also present customer premise capabilities critical to providing new Ethernet services. Experimental results for various services from the customer premise with the PATN architecture are also presented

Ballroom D

OThT • PMD: Modeling and Monitoring—Continued

OThT6 • 3:00 p.m.
Field Trial Results on Statistics of Fast Polarization Changes in Long Haul WDM Transmission Systems, *Peter M. Krummrich[1], Ernst-Dieter Schmidt[1], Werner Weiershausen[2], Arnold Mattheus[2]; [1]Siemens AG, Germany, [2]T-Systems, Germany.* Field trials were carried out to determine the statistics of fast polarization changes in optical networks. Important data enabling the definition of speed requirements for PMD compensators and adaptive equalizers could be obtained.

OThT7 • 3:15 p.m.
Modified Jones Matrix for Optical PMD Compensation, *Fred Heismann; Technical Consultant, USA.* We numerically simulate the average frequency dependence of the coupling that occurs between signal components in the two principal states of polarization and employ our results to define an improved transfer matrix for PMD compensation.

Notes

3:30 p.m.–4:00 p.m. BEVERAGE BREAK, EXHIBIT HALL

4:00 p.m.–6:30 p.m. OFC POSTDEADLINE PAPER SESSIONS

Ballroom E

OThU • Low Cost Lasers and Packaging—Continued

OThU7 • 3:00 p.m.
High Performance Planar Lightwave Circuit Triplexer with Passive Optical Assembly, *Henry Blauvelt, Al Benzoni, Jerry Byrd, Mark Downie, Charles Grosjean, Stuart Hutchinson, Robert Lee, Frank Monzon, Michael Newkirk, Joel Paslaski, Peter Sercel, David Vernooy, Rolf Wyss; Xponent Photonics, USA.* High performance, compact, planar lightwave circuit based triplexers have been built and tested. The triplexers utilize lasers, photodiodes, and filters that have been adapted to enable passive optical assembly of the triplexer

OThU8 • 3:15 p.m.
Simplified Optical Coupling and Alignment Scheme for Cost Effective 10 Gbit/s TOSA Modules Based on Edge Emitters Hermetically Packaged in Micro-Machined Silicon Structures, *Marcus Winter, Arnd Kilian, Ralf Hauffe; Hymite GmbH, Germany.* A simple optical coupling and alignment scheme is presented which enables the fabrication of cost effective 10 Gbit/s TOSA modules which are based on edge-emitting laser diodes packaged hermetically in micro-machined silicon structures.

Room 303A-B

OThV • Planar Lightwave Circuits—Continued

OThV6 • 3:00 p.m.
Novel Wide-Band Low-PDL Integrated Variable Optical Attenuator in Silica-on-Silicon, *Romanas Narevich[1], Gerhard Heise[2], Edvardas Narevicius[1], Ilya Vorobeichik[1], Jens Dieckroeger[2], Steve Wang[1], Detlef Krabe[2]; [1]OpTun Inc., USA, [2]Optun GmbH, Germany.* We present a novel wide band VOA with low PDL. Our device is symmetric MZI-based PLC component that uses y-junctions and adiabatic couplers. We describe a model that explains PDL for this VOA and enables polarization control.

OThV7 • 3:15 p.m.
2-D Array Waveguide Demultiplexing by Hybrid Waveguide and Free-Space Optics, *Trevor K. Chan, Maxim Abashin, Joseph E. Ford; Univ. of California at San Diego, USA.* We demonstrate array wavelength demultiplexing using a free-space demultiplexer to separate 9 orders from each of 8 AWG outputs onto an InGaAs camera, or scanned output fiber. This proof-of-principle device had 0.2nm channel -20dB bandwidth, >35dB extinction and 15-25dB loss.

Room 303C-D

OThW • FEC and Line Coding—Continued

OThW6 • 3:00 p.m.
Generalized Low-Density Parity-Check Codes for Long-Haul High-Speed Optical Communications, *Ivan B. Djordjevic[1], Olgica Milenkovic[2], Bane Vasic[1]; [1]Univ. of Arizona, USA, [2]Univ. of Colorado, USA.* BER performance of GLDPC codes outperforming currently known turbo and LDPC coding schemes utilized in optical communication systems is analyzed. Largest so far reported coding gain of at least 11 dB (at 40 Gb/s with 23.6% of redundancy) is demonstrated.

Room 304A-B

OThX • Measurements and Performance Monitoring—Continued

OThX4 • 3:00 p.m.
Low Probability Jitter Measurements in "Live" Serial Data Streams, *Thomas E. Waschura, James R. Waschura; SyntheSys Res. Inc., USA.* BER testers measure CDFs in real-time; however, BER applications have been limited to using repeating PRBS or fixed sequences. This paper presents altering the decision circuit to allow CDF accumulation in any data stream including "live" traffic.

OThX5 • 3:15 p.m.
Distributed Fiber Optic Intrusion Sensor System, *Juan C. Juarez, Henry F. Taylor; Texas A&M Univ., USA.* The first field tests of a system for detecting and locating intruders walking above or near a buried cable containing a single mode telecommunications fiber as the sensing element are reported.

Notes

3:30 p.m.–4:00 p.m. BEVERAGE BREAK, EXHIBIT HALL

4:00 p.m.–6:30 p.m. OFC POSTDEADLINE PAPER SESSIONS

Ballroom A

8:00 a.m.–10:00 a.m.
OFA • Network Testbeds
Biswanath Mukherjee; Univ. of California at Davis, USA, Presider

OFA1 • 8:00 a.m.
Extended Optical Broadcasting in Interconnected Flexible Metro WDM Ring Networks, *Cechan Tian, Susumu Kinoshita; Fujitsu Labs of America, Inc., USA.* An "extended" broadcast and select architecture across transparently connected metro core and metro collector/access ring networks are demonstrated. WDM channel paths can be dynamically reconfigured and selectively broadcast into multiple areas of metro access networks.

OFA2 • 8:15 a.m.
A Simple Single-Fiber CWDM Metro/Access Ring Network with Unidirectional OADM and Automatic Protection, *Zhaoxin Wang, Chinlon Lin, Chun-Kit Chan; The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We propose and demonstrate a simple and effective CWDM metro/access network architecture using unidirectional OADM for optical protection in a hub/access-node single-fiber ring. This physical-ring/logical-star architecture provides greater simplicity over previous designs requiring Bidirectional ADM.

Ballroom B

8:00 a.m.–10:00 a.m.
OFB • Fiber Structures for Advanced Amplifiers
Shu Namiki; Furukawa Electric Co. Ltd., Japan, Presider

OFB1 • 8:00 a.m. Invited
Photonic Crystal Fiber Amplifiers, *Minoru Yoshida[1], Junya Maeda[2]; [1]Kinki Univ., Japan, [2]Mitsubishi Cable Industries Ltd., Japan.* Characteristics of photonic crystal double clad fibers are introduced. Our research suggests that large numerical aperture in photonic crystal types are effective to reduce harmful non-linear optics in high power amplification.

Ballroom C

8:00 a.m.–10:00 a.m.
OFC • Fiber Gratings
Paul Westbrook; OFS Labs, USA, Presider

OFC1 • 8:00 a.m. Invited
Multi-Wavelength Devices Based on Superimposed Chirped Fiber Bragg Gratings, *S. LaRochelle, G. Brochu, S. Doucet, S. Pereira; Univ. Laval, Canada.* All-fiber resonators are created by superimposing wideband chirped gratings. We discuss the properties of multi-channel devices based on this technology using single-cavity and coupled-cavity designs, including applications to multi-wavelength fiber lasers and tunable dispersion compensation.

Ballroom D

8:00 a.m.–10:00 a.m.
OFD • Polymers
Robert Norwood; Univ. of Arizona, USA, Presider

OFD1 • 8:00 a.m.
Passive Devices for FTTH Systems Based on Replicated Polymer Optical Waveguides, *Kazuyuki Hayamizu, Naru Yasuda, Yasunari Kitajima, Hayami Hosokawa; Omron Corp., Japan.* A novel replication technology for fabricating polymer optical waveguides has been developed. By utilizing this technology, optical coupler modules and a WDM module are successfully demonstrated with practical characteristics and high reliability for FTTH systems.

OFD2 • 8:15 a.m.
Compact High Efficiency Bends in Perfluorocyclobutyl Polymer Waveguides, *Gregory P. Nordin, Jaime Cardenas, Seunghyun Kim; NMDC, USA.* We report the design, fabrication, and measurement of high efficiency, compact 45° single air interface bends in perfluorocyclobutyl (PFCB) copolymer waveguides. Experimental measurement reveals a low loss of 0.30±0.03dB/bend for TM polarization and 0.33±0.03dB/bend for TE polarization.

Notes

Ballroom E

8:00 a.m.–10:00 a.m.
OFE • Optical Nonlinear Processing
Shigeru Nakamura; NEC System Platform Lab, Japan, Presider

OFE1 • 8:00 a.m. Invited
Optical Nonlinear Processing Using PPLN, *Martin M. Fejer; Stanford Univ., USA.* Optical-frequency mixing can accomplish a variety of wavelength-and time-domain all-optical signal processing functions. Operation at speeds up to 160 Gb/s, bandwidths of 70 nm, and with as few as 400-photon pulses have been demonstrated in periodically-poled lithium niobate (PPLN) devices.

Room 303A-B

8:00 a.m.–10:00 a.m.
OFF • 40 Gb/s and Beyond
Wilfried Idler; Alcatel Submarine Networks, Germany, Presider

OFF1 • 8:00 a.m.
Field Demonstration of 160-Gb/s OTDM Signal Using Eight 20-Gb/s 2-Bit/Symbol Channels over 200 km, *Tetsuya Miyazaki, Yoshinari Awaji, Yukiyoshi Kamio, Fumito Kubota; Natl. Inst. of Info. & Com. Tech., Japan.* We demonstrated transmission of 160-Gb/s OTDM signals comprising eight 20-Gb/s 2-bit/symbol ASK-DPSK tributary channels over 200 km of installed fiber to investigate the effect of bandwidth compression on transmission impairment due to polarization mode dispersion.

OFF2 • 8:15 a.m.
PMD Tolerance of 8x170 Gbit/s Field Transmission Experiment over 430 km SSMF with and without PMDC, *Ralph Leppla[1], Sascha Vorbeck[1], Eugen Lach[2], Michael Schmidt[2], Martin Witte[2], Fred Buchali[2], Esther Le Rouzic[3], Suzanne Salauen[3]; [1]T-Systems, Germany, [2]Alcatel R&I, Germany, [3]France Telecom R&D, France.* We report on a 8x170 Gbit/s DWDM/OTDM (1.28 Tbit/s) transmission experiment over 430 km field-installed SSMF including adaptive PMD compensation and polarization demultiplexing. The System showed strong impact on PMD changes and stable transmission including PMDC.

Room 303C-D

8:00 a.m.–9:15 a.m.
OFG • Modulation Techniques
John C. Cartledge; Queen's Univ., Canada, Presider

OFG1 • 8:00 a.m.
Generation of Chirped RZ-DPSK Signals Using a Single Mach-Zehnder Modulator, *Xiang Liu, Y.-H. Kao; Lucent Technologies, USA.* We experimentally generate positively and negatively chirped return-to-zero differential phase-shift keyed signals using a single Mach-Zehnder modulator at 10 Gb/s with a receiver sensitivity (at BER=10-9) of about -42 dBm in an optically pre-amplified receiver.

OFG2 • 8:15 a.m.
Novel Modulation Scheme for Optical Continuous-Phase Frequency-Shift Keying, *Takahide Sakamoto, Tetsuya Kawanishi, Tetsuya Miyazaki, Masayuki Izutsu; NICT, Japan.* We propose a novel scheme for continuous-phase frequency-shift-keying (CP-FSK) optical modulation. By synchronizing the baseband signal with the clock for sideband generation, external CP-FSK modulation is demonstrated at 10 Gbit/s for the first time.

Room 304A-B

8:00 a.m.–10:00 a.m.
OFH • Characterization and Application of Transmission Fiber
Ekaterina Golovchenko; Tyco Telecommunications, USA, Presider

OFH1 • 8:00 a.m.
Transmission Fiber Optimized for Metro Optical Network, *Louis-Anne de Montmorillon[1], Pierre Sillard[1], Marianne Astruc-Bigot[1], Bruno Dany[1], Pascale Nouchi[1], Bruno Lavigne[2], Elodie Balmefrezol[2], Jean-Christophe Antona[2], Olivier Leclerc[2]; [1]Draka Comteq, France, [2]Alcatel R&I, France.* Transmission fiber, optimized for metropolitan applications, is realized and tested in typical system configuration. It offers a low dispersion and slope for broadband, uncompensated reach, while maintaining large effective area to suppress detrimental non-linear effects.

OFH2 • 8:15 a.m.
Trade-off of Dispersion Slope and Effective Area in Ultra Low Slope NZ-DSF for Non-Dispersion-Compensated WDM Metro Transmission, *Yoshihiro Emori[1], Naomi Kumano[1], Kazunori Mukasa[1], Ryuichi Sugizaki[1], Misao Sakano[1], Lynn E. Nelson[2]; [1]Furukawa Electric, Japan, [2]OFS Labs, USA.* We investigate the nonlinear penalty of ultra-low-slope NZ-DSF with less than 50-μm² effective area in non-dispersion-compensated systems. For 80- and 155-km, 10-Gb/s transmission, negligible nonlinear penalty was found for launch powers up to 0 dBm/ch.

Notes

Ballroom A

OFA • Network Testbeds—Continued

OFA3 • 8:30 a.m. Invited
Photonics R&D Activities in Mainland China, *Shizhong Xie; Tsinghua Univ., China.* Current status of main national R&D programs on optical communication system and network technologies, launched to sustain a rapid growth of telecom networks in mainland China are reviewed. Research accomplishment of some photonic related R&D projects will be presented.

OFA4 • 9:00 a.m.
A Wide-Area Carrier-Distributed WDM-Based Access Network Accommodating GbE and 10 GbE Services, *Hirotaka Nakamura, Hiro Suzuki, Jun-ichi Kani, Katsumi Iwatsuki; NTT Corp., Japan.* This paper describes a wide-area carrier-distributed WDM-based access network accommodating GbE and 10 GbE services over metro/access areas. A transmission experiment is conducted by using the colorless ONUs of GbE and 10 GbE and its performance is evaluated.

Ballroom B

OFB • Fiber Structures for Advanced Amplifiers—Continued

OFB2 • 8:30 a.m.
Microstructured Phosphate Glass Fiber Lasers with Large Mode Areas, *Li Li[1], Axel Schülzgen[1], Valery L. Temyanko[1], Tiequn Qiu[1], Arash Mafi[2], Jerome V. Moloney[2], Nasser Peyghambarian[1]; [1]Optical Sciences Ctr., Univ. of Arizona, USA, [2]Arizona Ctr. for Mathematical Sciences, Univ. of Arizona, USA.* We report fabrication and testing of the first phosphate glass microstructured fiber lasers. From cladding-pumped, 11 cm long fiber lasers of 430 μm^2 core area we obtain 3 W cw output with good beam quality.

OFB3 • 8:45 a.m.
All-Fibre Frequency Conversion in Long Periodically Poled Silica Fibres, *Costantino Corbari, Albert Canagasabey, Morten Ibsen, Francesco Mezzapesa, Cristophe Codemard, Johan Nilsson, Peter G. Kazansky; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* Efficient all-fibre frequency doubling of 1.5μm pulsed fibre laser has been demonstrated. 3.6mW of second-harmonic light in fundamental mode was produced by quasi-phase-matching in a 11.5cm long periodically poled germanosilicate fibre. The $\chi^{(2)}$-grating was fabricated by continuous periodic-UV-erasure.

OFB4 • 9:00 a.m. Invited
Application of Fundamental-Mode Cutoff for Novel Amplifiers and Lasers, *Mark A. Arbore; Lightwave Electronics Corp., USA.* Depressed-cladding fibers with fundamental-mode cutoffs provide high distributed losses at long wavelengths and low losses at short wavelengths. ASE suppression at 4-level transitions enables gain on shorter-wavelength, 3-level transitions. We discuss applications to Er-, Tm, Nd-, and Yb-doped fiber amplifiers.

Ballroom C

OFC • Fiber Gratings—Continued

OFC2 • 8:30 a.m.
Demonstration of a Novel All-Fiber Bandpass Acousto-Optic Tunable Filter, *Pedram Z. Dashti, Chang-Seok Kim, Qun Li, Henry P. Lee; Univ. of California at Irvine, USA.* An all-fiber tunable bandpass filter is demonstrated. A dual acousto-optic grating inside a Sagnac loop changes the polarization of the light over a narrow bandwidth which redirects the light from reflection to the transmission port.

OFC3 • 8:45 a.m.
Narrow-Bandwidth Acousto-Optic Tunable Filter with Low Polarization Dependence, *Dong Il Yeom[1], Myeong Soo Kang[1], Hee Su Park[1], Byoung Yoon Kim[1], Hyo Sang Kim[2]; [1]Korea Advanced Inst. of Science and Technology, Republic of Korea, [2]Novera Optics Korea, Inc, Republic of Korea.* We demonstrate a narrow-bandwidth all-fiber acousto-optic tunable filter with low polarization dependence using a dispersion compensating fiber. The 3-dB bandwidth at 10-dB notch was 0.66 nm, and the polarization-dependent wavelength shift was 0.04 nm.

OFC4 • 9:00 a.m.
Apodization of an Elliptic-Core Two-Mode Fiber Acousto-Optic Tunable Filter, *Hyun Chul Park, Hee Su Park, Byoung Yoon Kim; Korea Advanced Inst. of Science and Technology, Republic of Korea.* We demonstrate a new apodization technique for an elliptic-core two-mode fiber acousto-optic tunable filter based on controlling the acoustic polarization. The intensity of the sidelobes in the filter spectrum was reduced by almost 6 dB using this apodization technique.

Ballroom D

OFD • Polymers—Continued

OFD3 • 8:30 a.m. Invited
Polymer/Silica Hybrid Waveguide Devices, *Tony Kowalczyk[1], W. K. Bischel[1], M. Jubber[2], H. Bulthuis[2]; [1]Gemfire Corp., USA, [2]Gemfire Europe Ltd., USA.* We discuss the performance merits associated with the development of glass-polymer hybrid components. We describe the status and future prospects of hybrid components that include hybrid (athermal) arrayed waveguide grating devices and other building blocks for achieving higher levels of integration.

OFD4 • 9:00 a.m.
Wavelength Independent Vertically-Coupled Polymer Optical Waveguide Switch, *Kaixin Chen, Pak L. Chu, Hau Ping Chan, Kin Seng Chiang; City Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We propose a composite polymer vertically-coupled optical waveguide switch that offers a wavelength independent switching characteristics. The variation of the extinction ratio within the C-band is less than 4dB for bar state and 1dB for cross state.

Notes

Ballroom E

OFE • Optical Nonlinear Processing—Continued

OFE2 • 8:30 a.m.
Virtual Grouped-Wavelength-Path Switching Based on QPM-LN Waveband Converter and Supercontinuum Wavelength-Bank Source, *Jun Yamawaku, Etsushi Yamazaki, Atsushi Takada, Toshio Morioka, Kazunori Suzuki; Nippon Telegraph and Telephone Corp., Japan.* Virtual grouped-wavelength-path switching is proposed and demonstrated based on polarization-independent waveband conversion in QPM-LN and supercontinuum wavelength-bank source. The 64ch-10Gbit/s waveband is wavelength-converted, switched and transmitted through field-installed fibers in the JGN II test bed.

OFE3 • 8:45 a.m.
Ultrafast All-Optical NOR Gate Based on Intersubband and Interband Modulation Operating at Communication Wavelengths, *Makoto Naruse[1], Tetsuya Miyazaki[1], Fumito Kubota[1], Haruhiko Yoshida[2], Hiroshi Ishikawa[2]; [1]Natl. Inst. of Information and Communications Technology, Japan, [2]The Femtosecond Technology Res. Assn. (FESTA), Japan.* An ultrafast all-optical NOR gate using intersubband and interband transitions in quantum wells is proposed. A proof-of-principle experiment is demonstrated using InGaAs/AlAsSb coupled quantum well structures operating at communication wavelengths (1.55 μm and 1.3 μm).

OFE4 • 9:00 a.m.
Waveguide Design of InGaAs/AlAs/AlAsSb Inter-Subband Transition Optical Switch, *Shigeaki Sekiguchi, Takashi Simoyama, Haruhiko Yoshida, Junichi Kasai, Teruo Mozume, Hiroshi Ishikawa; Femtosecond Technology Res. Assn., Japan.* InGaAs/AlAs/AlAsSb inter-subband transition optical switch waveguide is designed for low driving energy. By applying a narrow high-mesa waveguide and thin barriers, the driving energy decreases significantly compared to the conventional ridge structure.

Room 303A-B

OFF • 40 Gb/s and Beyond—Continued

OFF3 • 8:30 a.m.
320 Gb/s Single-Polarization OTDM Transmission over 80 km Standard Transmission Fiber, *Andrei I. Siahlo, Jorge Seoane, Anders T. Clausen, Leif K. Oxenløwe, Palle Jeppesen; COM Ctr., Technical Univ. of Denmark, Denmark.* 320 Gb/s single-channel and single-polarization error-free transmission over continuous spans of either 80 km SMF or 77 km NZDSF are realized.

OFF4 • 8:45 a.m.
170 Gbit/s Single-Polarization Transmission over 650 km SSMF with 130 km Spans Using RZ-DPSK, *Stefan Weisser[1], Lutz Raddatz[1], Andreas Benz[1], Sebastian Ferber[2], Christof Boerner[2], Reinhold Ludwig[2], Hans-Georg Weber[2]; [1]Lucent Technologies, Germany, [2]Heinrich-Hertz Inst., Germany.* We report on single-polarization 170 Gbit/s transmission over 650 km SSMF using RZ-DPSK modulation format with base rate 42.6 Gbit/s, with hybrid EDFA/Raman amplification in all five 130 km spans and with error-free transmission without FEC in all tributaries.

OFF5 • 9:00 a.m. Invited
40G Over 10G Infrastructure–Dispersion Management Issues, *Hans Bissessur; Alcatel, France.* Transmission at 40G over a 10G infrastructure needs compatible dispersion management. The optimum chromatic dispersion at 40 Gb/s is investigated, and its adjustment to a 10 Gb/s infrastructure over SMF or NZDSF fiber types is discussed.

Room 303C-D

OFG • Modulation Techniques—Continued

OFG3 • 8:30 a.m.
Demonstration of a 160-Gb/s Group-Alternating Phase CSRZ Format Featuring Simplified Clock Recovery and Improved Nonlinear Performance, *Yikai Su[1], Lothar Möller[2], Roland Ryf[2], Xing Wei[2], Chongjin Xie[2], Xiang Liu[2]; [1]Shanghai Jiao Tong Univ., China, [2]Bell Labs, Lucent Technologies, USA.* We propose and demonstrate a new 160-Gb/s signal format employing phase inversion of every four consecutive bits in a group. This format enables simple clock recovery by spectral filtering, and increases the nonlinear tolerance compared to CSRZ signals.

OFG4 • 8:45 a.m.
40-Gb/s RZ-DQPSK Time-Polarization Interleaving, *Pierpaolo Boffi[1], Lucia Marazzi[1], Paolo Martelli[1], Livio Paradiso[1], Paola Parolari[1], Aldo Righetti[1], Rocco Siano[1], Mario Martinelli[1,2]; [1]CoreCom, Italy, [2]Dept. of Electronics and Information, Politecnico di Milano, Italy.* Time-polarization interleaving 40-Gb/s RZ-DQPSK with 100-ps symbol-slot is received with integrated equipment designed for 10-Gsymbol/s DPSK detection without polarization demultiplexing. BER comparison with other 40Gb/s equivalent modulation formats is experimentally investigated in back-to-back configuration.

OFG5 • 9:00 a.m.
Optimal Receiver Bandwidths, Bit Error Probabilities and Chromatic Dispersion Tolerance of 40 Gbit/s Optical 8-DPSK with NRZ and RZ Impulse Shaping, *Michael Ohm, Joachim Speidel; Univ. of Stuttgart, Germany.* For the first time, optimal optical and electrical receiver bandwidths, bit error probabilities and chromatic dispersion tolerance of optical differential 8-level phase-shift keying are studied using a Karhunen-Loeve based semi-analytical method.

Room 304A-B

OFH • Characterization and Application of Transmission Fiber—Continued

OFH3 • 8:30 a.m.
Correlation-Based Measurement of Distributed Raman Gain in Single-Mode Fibers, *Nobuhiro Takagi[1], Tsuneo Horiguchi[1], Atsushi Saito[1], Kunihiro Toge[2], Kazuo Hogari[2]; [1]Shibaura Inst. of Technology, Japan, [2]NTT Access Service Systems Labs, Japan.* We present a new correlation-based pump-probe system to measure the distributed Raman gain in single-mode fibers. Our method shows better performance over the conventional method which uses a single pulse for the pump.

OFH4 • 8:45 a.m.
Modeling the Nonlinear Index of Optical Fibers, *Pierre Sillard[1], Pascale Nouchi[1], Jean-Christophe Antona[2], Sébastien Bigo[2]; [1]Draka Comteq, an Alcatel/Draka Co., France, [2]Alcatel R&I, France.* We propose and validate experimentally a simple model that allows us to calculate the nonlinear index, n_2, of any fiber type. Single-mode and higher-order-mode DCFs are investigated and n_2 dependence on chromatic dispersion is analyzed.

OFH5 • 9:00 a.m.
New Dispersion Decreasing Fiber with High SBS Threshold for Nonlinear Signal Processing, *Ming-Jun Li[1], Shenping Li[1], Daniel A. Nolan[1], U. G. Achmetshin[2], M. M. Bubnov[2], A. N. Guryanov[2], E. M. Dianov[2], V. F. Khopin[2], A. A. Sysoliatin[2]; [1]Corning Inc., USA, [2]General Physics Inst., Russian Federation.* A new dispersion decreasing fiber with reduced SBS by changing the core refractive index was designed and fabricated. SBS threshold improvement of 7dB over the conventional nonlinear fiber was demonstrated.

Notes

Ballroom A

OFA • Network Testbeds—Continued

OFA5 • 9:15 a.m.
Demonstration of a 6 x 10 Gb/s Multiuser Time-Slotted SPECTS O-CDMA Network Testbed, *Wei Cong, Ryan P. Scott, Vincent J. Hernandez, Kebin Li, Brian H. Kolner, Jonathan P. Heritage, S. J. Ben Yoo; Univ. of California at Davis, USA.* We demonstrate error-free performance of a six-user, 10 Gb/s/user, time-slotted SPECTS O-CDMA network testbed. Careful system engineering and a nonlinear thresholder effectively suppress multiuser interference.

OFA6 • 9:30 a.m.
A Testbed for Optical Burst Switching Networks, *Hongxiang Guo[1], Jian Wu[1], Zhou Lan[1], Zehua Gao[1], Xuanfei Li[1], Jintong Lin[1], Yuefeng Ji[1], Jianpin Chen[2], Xinwan Li[2]; [1]Beijing Univ. of Posts and Telecommunications, China, [2]Shanghai Jiaotong Univ., China.* This paper presents a testbed for optical burst switching network based on priority JET scheme, and demonstrates flexible node architectures. Also, experimental results verify functions of various modules, flexibility and stable operation of the testbed.

Ballroom B

OFB • Fiber Structures for Advanced Amplifiers—Continued

OFB5 • 9:30 a.m.
Investigation of New Erbium Doped Fiber Design with Improved Splice Performance, *Torben Veng, Bera Pálsdóttir; OFS Fitel Denmark I/S, Denmark.* An Erbium doped fiber (EDF) having a new type of refractive index profile, useful for optimizing fusion splicing abilities, is studied with respect to splice performance and gain characteristics.

Ballroom C

OFC • Fiber Gratings—Continued

OFC5 • 9:15 a.m.
Fabrication of Strong Re-Writable Long-Period Fiber Gratings with a CO_2 Laser, *Victor Grubsky, Jack Feinberg; Univ. of Southern California, USA.* We show that the sensitivity of boron-doped fibers to CO_2 radiation can be enhanced by a uniform pre-exposure. Resulting gratings could be erased with a similar uniform exposure and recorded again with no loss of fiber sensitivity.

OFC6 • 9:30 a.m. Invited
Femtosecond Laser Fabrication of Photonic Devices, *Stephen J. Mihailov, Christopher W. Smelser, Dan Grobnic, Robert B. Walker, Huimin Ding, Ping Lu; Communications Res. Ctr. Canada, Canada.* Recent developments in femtosecond laser fabrication of fiber Bragg grating (FBG) photonics devices and associated ultrafast beam interaction with phase masks are presented. These novel FBG devices are useful for telecommunication and fiber sensor applications.

Ballroom D

OFD • Polymers—Continued

OFD5 • 9:15 a.m.
A Pixelized VOA Based on Liquid Crystal on Silicon, *Masafumi Ide[1], Yasushi Hosaka[1], Akira Suguro[1], Atsushi Shiraishi[1], Yoshiyuki Abe[2], Tokuyuki Nakayama[2], Hideharu Yokozuka[2]; [1]Citizen Watch Co., Ltd., Japan, [2]Sumitomo Metal Mining Co., Ltd., Japan.* We have fabricated a 512-pixel liquid crystal VOA with biased PWM based on liquid crystal on silicon, using ITiO as a common electrode. The VOA is suitable for making tunable filters with low driver voltage.

OFD6 • 9:30 a.m.
Polymeric Optical Interconnect for Chip-to-Chip Communication, *Jon V. DeGroot[1], Shedric O. Glover[1], Mark J. Dyer[2], William K. Bischel[2]; [1]Dow Corning Corp., USA, [2]Genfire Corp., USA.* An optical interconnect has been produced on FR-4 board. The interconnect consists of photo-defined optical layers coupled to VCSELs and photodetectors via out of plane mirrors. Materials, fabrication methods and test results will be discussed.

Notes

Ballroom E

OFE • Optical Nonlinear Processing—Continued

OFE5 • 9:15 a.m.
Broadly Tunable Optical Parametric Oscillators with up to 82-GHz Pulse Repetition Rate and Very High Output Power, *Steve Lecomte[1], Rüdiger Paschotta[1], Ursula Keller[1], Susanne Pawlik[2], Berthold Schmidt[2], Kentaro Furusawa[3], Andrew Malinowski[3], David J. Richardson[3]; [1]ETH Zürich, Switzerland, [2]Bookham AG, Switzerland, [3]Optoelectronics Res. Ctr., UK.* We present optical parametric oscillators with 39-GHz and 82-GHz repetition rates, generating 2.1 W and 0.9 W of average output power, respectively. The signal wavelength is broadly tunable in the 1.5-μm spectral region.

OFE6 • 9:30 a.m.
Nearly Quantum-Limited Timing Jitter of Passively Mode-Locked 10-GHz Diode-Pumped Er:Yb:Glass Lasers, *Rüdiger Paschotta[1], Benjamin Rudin[1], Adrian Schlatter[1], Simon C. Zeller[1], Gabriel J. Spühler[2], Lukas Krainer[2], Ursula Keller[1], Nils Haverkamp[3], Harald R. Telle[3]; [1]ETH Zürich, Switzerland, [2]GigaTera, Switzerland, [3]Physikalisch-Technische Bundesanstalt, Germany.* A novel measurement scheme demonstrates that the timing jitter of free-running passively mode-locked 10-GHz Er:Yb:glass lasers can be close to the quantum limit. With feedback stabilization, even lower jitter (27 fs rms, 6 Hz - 1.56 MHz) is achieved.

Room 303A-B

OFF • 40 Gb/s and Beyond—Continued

OFF6 • 9:30 a.m.
Experimental Comparison of System Penalties Due to 1st Order and Multi-Order Polarization Mode Dispersion, *Kate Cornick[1,2], Misha Boroditsky[2], Nicholas Frigo[2], Misha Brodsky[2], Sarah D. Dods[3], Peter Magill[2]; [1]Natl. ICT Australia, Victorian Res. Lab, Univ. of Melbourne, Australia, [2]AT&T Lab, USA, [3]Australian Photonics CRC, Photonics Res. Lab, Univ. of Melbourne, Australia.* Using vectorially resolved launch SOPs, we show that high order PMD, present in real fibers, introduces a deterministic correction to the accepted first-order system penalty, and an additional uniformly distributed scatter, uncorrelated to the second order PMD vector.

Room 303C-D

Room 304A-B

OFH • Characterization and Application of Transmission Fiber—Continued

OFH6 • 9:15 a.m.
Optical-Fiber-Based Autocorrelation Technique Using a Tunable DGD Element and Highly-Nonlinear Fiber, *Ting Luo[1], Zhongqi Pan[2], Changyuan Yu[1], Lianshan Yan[1], Saurabh Kumar[1], Bo Zhang[1], Micha Adler[1], Alan Eli Willner[1], Steve Yao[3]; [1]Univ. of Southern California, USA, [2]Univ. of Louisiana, USA, [3]General Photonics Corp., USA.* We demonstrate a novel optical-fiber-based autocorrelator using a tunable DGD element and highly-nonlinear fiber. 20 G, 40 G, and 80 G pulse widths are measured. Our measurement results agree well with the measurements using a conventional technique.

OFH7 • 9:30 a.m.
Tunable 40 GHz Pulse Source Based on XPM-Induced Wavelength Shifting in Highly Nonlinear Fiber, *Jie Li, Anders Berntson; Acreo AB, Sweden.* A simple and robust 40 GHz pulse source has been demonstrated by using cross-phase modulation induced wavelength shifting in 200 m highly nonlinear fiber with subsequent optical filtering. The generated pulses are pulse width and wavelength tunable.

Notes

Ballroom A

OFA • Network Testbeds—Continued

OFA7 • 9:45 a.m.
The Demonstration of Congestion-Controlled Optical Burst Switching Network Utilizing Two-Way Signaling-Field Trial in JGN II Testbed, *Akio Sahara, Ryoichi Kasahara, Etsushi Yamazaki, Shigeki Aisawa, Masafumi Koga; NTT, Japan.* We demonstrate congestion controlled optical burst switching utilizing two-way signaling in field trials. The optical bursts, created in each node with Poisson probability, were routed within 20msec.

Ballroom B

OFB • Fiber Structures for Advanced Amplifiers—Continued

OFB6 • 9:45 a.m.
Raman Gain and Laser Generation in Germania-Based Core Optical Fibers in 1.1-2.2 µm Spectral Range, *Valery M. Mashinsky[1], Igor A. Bufetov[1], Alexei V. Shubin[1], Mikhail A. Melkumov[1], Oleg I. Medvedkov[1], Evgeny M. Dianov[1], Alexei N. Guryanov[2], Vladimir F. Khopin[2], Mikhail Yu Salgansky[2]; [1]Fiber Optics Res. Ctr. at the General Physics Inst., Russian Acad. of Sciences, Russian Federation, [2]Inst. of Chemistry of High-Purity Substances, Russian Acad. of Sciences, Russian Federation.* Raman amplification and generation in single mode fiber with germania-based core and silica cladding were investigated in 1.1-2.2 µm spectral range. Fiber lasers' output power up to 10 W was obtained.

Ballroom C

Ballroom D

OFD • Polymers—Continued

OFD7 • 9:45 a.m.
UV-Written Buried Waveguide Devices in Epoxy-Coated Benzocyclobutene, *Kin S. Chiang, Kar Pong Lor, Qing Liu, Hau Ping Chan; City Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We find that properly treated epoxy (OPTOCAST 3505) is non-photosensitive at the UV-wavelength 248 nm. Using it as the cladding material, several buried channel waveguide devices written into benzocyclobutene by the UV technique are demonstrated.

Notes

10:00 a.m.–10:30 a.m. BEVERAGE BREAK, 300 LEVEL LOBBY

10:30 a.m.–12:30 p.m.
OFI • PONs
C.K. (Calvin) Chan; The Chinese Univ. of Hong Kong, China, Presider

OFI1 • 10:30 a.m.
Feasibility Demonstration of 100km Reach DWDM SuperPON with Upstream Bit Rates of 2.5Gb/s and 10Gb/s, *Giuseppe Talli, Paul D. Townsend; Photonic Systems Group, Univ. College Cork, Ireland.* We propose and demonstrate the feasibility of a 100km reach, remotely-seeded DWDM SuperPON employing a colorless, monolithically-integrated, SOA-EAM modulator to provide upstream customer data channels operating at 2.5Gb/s or 10Gb/s.

10:30 a.m.–12:30 p.m.
OFJ • Pulsed Lasers
Stojan Radic; Univ. of Califonia at San Diego, USA, Presider

OFJ1 • 10:30 a.m. Invited
Mode-Locked Lasers for Frequency Standards and Time/Frequency Transfers, *Steven Cundiff, Peter A. Roos; JILA, USA.* Precision stabilization of mode-locked lasers, by locking them to optical frequency transitions, has lead to remarkable advances in high accuracy frequency standards and is enabling improvements of time and frequency transfer over fiber.

10:30 a.m.–12:30 p.m.
OFK • Resonator and Sagnac-Based Devices
Kin S. Chiang; City Univ. of Hong Kong, Hong Kong Special Administrative Region of China, Presider

OFK1 • 10:30 a.m.
High-Index-Contrast, Wide-FSR Microring-Resonator Filter Design and Realization with Frequency-Shift Compensation, *Milos A. Popovic, Michael R. Watts, Tymon Barwicz, Peter T. Rakich, Luciano Socci, Erich P. Ippen, Franz X. Kartner, Henry I. Smith; MIT, USA.* Rigorous electromagnetic simulations are used to design high-index-contrast microring-resonator filters. The first fabricated third-order filters compensated for passband distortion due to coupling-induced and fabrication-related frequency shifts demonstrate a 20nm FSR and the highest reported thru-port extinction (14dB).

10:30 a.m.–12:30 p.m.
OFL • Novel Devices
Christopher Doerr; Bell Labs, Lucent Technologies, USA, Presider

OFL1 • 10:30 a.m. Invited
Si Wire Waveguide Fabrication and Microphotonics Devices, *Seiichi Itabashi, Hiroshi Fukuda, Tai Tsuchizawa, Toshifumi Watanabe, Jun-ichi Takahashi, Tetsufumi Shoji, Koji Yamada; NTT, Japan.* We report our recent progress in Si wire waveguide fabrication and Si-based optical devices. The low-loss waveguides fabrication promises size reduction and high-density integration of passive and active functional optical circuits on a wafer.

Ballroom E

OFE • Optical Nonlinear Processing—Continued

OFE7 • 9:45 a.m.
Ultrafast Optical Delay Line Using Soliton Propagation between a Time-Prism Pair, *James van Howe, Chris Xu; Cornell Univ., USA.* Using soliton propagation between a time-prism pair, we apply time-prisms to ultrashort pulses and demonstrate an all-fiber, programmable optical delay line with a scan rate of 0.5 GHz, a delay range of 33.0 ps.

Room 303A-B

OFF • 40 Gb/s and Beyond—Continued

OFF7 • 9:45 a.m.
Timing-Jitter in High Bit-Rate WDM Communication Systems Due to PMD-Nonlinearity Interaction, *Reza Khosravani; Sonoma State Univ., USA.* We show that the interaction of polarization-mode-dispersion and cross-phase-modulation in 10 and 40 Gbit/s WDM systems results in a significant timing-jitter, even in the absence of a PMD compensator. An acceptable PMD level can generate unacceptable jitter in WDM systems.

Room 303C-D

Room 304A-B

OFH • Characterization and Application of Transmission Fiber—Continued

OFH8 • 9:45 a.m.
Polarization-Insensitive 40-Gb/s Wavelength Converter Using Cross-Phase Modulation in Twisted Fiber and Optical Filtering, *Takuo Tanemura, Jun Suzuki, Kazuhiro Katoh, Kazuro Kikuchi; RCAST, Univ. of Tokyo, Japan.* We demonstrate all-optical wavelength conversion with 0.3-dB polarization-sensitivity, using cross-phase modulation in a twisted fiber and optical filtering. Error-free operation with only 1-dB penalty is realized at 40 Gbit/s with the input signal polarization scrambled.

Notes

10:00 a.m.–10:30 a.m. BEVERAGE BREAK, 300 LEVEL LOBBY

10:30 a.m.–12:30 p.m.
OFM • Detectors and Receivers
Andreas Umbach; u2t Photonics AG, Germany, Presider

OFM1 • 10:30 a.m.
Highly Efficient PIN Photodetector Module for 80 Gbit/s and Beyond, *Andreas Beling, Heinz-Gunter Bach, Gebre Giorgis Mekonnen, Thomas Eckhardt, Reinhard Kunkel, Detlef Schmidt, Colja Schubert; Heinrich-Hertz-Inst., Fraunhofer-Inst. für Nachrichtentechnik, Germany.* A photodetector module with 0.63 A/W responsivity at 1.55 μm and 85 GHz bandwidth has been developed. Successful operation at 80 and 160 Gbit/s RZ data rates with Vpp > 0.5 V is reported.

10:30 a.m.–12:15 p.m.
OFN • 40 Gb/s Transmission
Peter M. Krummrich; Siemens AG, Germany, Presider

OFN1 • 10:30 a.m.
40-Gb/s Field Transmission through 540 km SSMF Using the APRZ Modulation Format, *Marco Forzati[1], Anders Berntson[1], Jonas Mårtensson[1], Anders Djupsjöbacka[1], Jie Li[1], Stefan Melin[2], Hans Carlden[2]; [1]Acreo AB, Sweden, [2]Telia Sonera AB, Sweden.* We report the first field transmission experiment using the APRZ modulation format for 40-Gb/s transmission through 540 km SSMF, which confirms the improved nonlinear tolerance of APRZ. The optimum phase-modulation amplitude in this experiment is $\pi/2$.

10:30 a.m.–12:00 p.m.
OFO • Electrical Processing
Michel W. Chbat; Siemens Communications, USA, Presider

OFO1 • 10:30 a.m. Invited
Block Turbo Code Based Soft-Decision FEC, *Katsuhiro Shimizu, Takashi Mizuochi; Mitsubishi Electric Corp., Japan.* The technical challenges and potential applications of Block Turbo Code based soft-decision FEC are discussed. Its large coding gain and the consequent reduction of fiber nonlinearity effects will have a positive impact on the cost-effectiveness of optical networks.

10:30 a.m.–12:30 p.m.
OFP • Emerging Applications and Technologies
Hans-Martin Foisel; T-Systems Technology Ctr., Germany, Presider

OFP1 • 10:30 a.m. Invited
Ethernet Evolution Towards Carrier Applications, *Lubo Tancevski; Alcatel R&I, USA.* We examine the introduction of Ethernet services in carrier networks and the necessary requirements on the evolution of the Ethernet feature-set. We outline how these requirements for carrier-grade operation can sucessfully be met.

Ballroom A

OFI • PONs—Continued

OFI2 • 10:45 a.m.
Upstream Experiments on the Gigabit PON Physical Medium Layer, *Dieter Verhulst[1], Yunchan Yi[1], Xing-Zhi Qiu[1], Stefaan Verschuere[1], Zhe Lou[1], Peter Ossieur[1], Johan Bauwelinck[1], Xin Yin[1], Jan Vandewege[1], Benoit De Vos[2]; [1]INTEC-IMEC, Belgium, [2]Alcatel R&I, Belgium.* First time demonstration of a high performance 1.25 Gbit/s GPON burst-mode uplink exceeding the ITU-T G.984 Recommendation and supporting Power Leveling Mechanism (PLM). A burst-mode receiver sensitivity of -31.6 dBm was achieved with a dynamic range of 21.9 dB.

OFI3 • 11:00 a.m.
ONU Authentication Technique Using Loopback Modulation within a PON Disturbance Environment, *Yukio Horiuchi, Noboru Edagawa; KDDI R&D Labs, Japan.* ONU authentication method with extraordinary interference immunity is proposed to specify defective ONU. We successfully demonstrated low-speed data communication for subscriber identification by using ONU loopback on-off-keying modulation and auto-correlation detection within optically disturbed environment.

OFI4 • 11:15 a.m.
Survivable Network Architectures for WDM PON, *Eui Seung Son, Kwan Hee Han, Jun Haeng Lee, Yun C. Chung; KAIST, Republic of Korea.* We propose and demonstrate a simple self-protecting architecture for WDM PON. The protection time was less than 10 ms, and the power penalty caused by the protection process was negligible.

Ballroom B

OFJ • Pulsed Lasers—Continued

OFJ2 • 11:00 a.m.
Long-Term Carrier Envelope Phase Locking of a PM Fiber Frequency Comb Source, *Ingmar Hartl[1], Liang Dong[1], Martin E. Fermann[1], Thomas R. Schibli[2], Atushi Onae[2], Feng-Lei Hong[2], Hajime Inaba[2], Kaoru Minoshima[2], Hirokazu Matsumoto[2]; [1]IMRA America Inc., USA, [2]Natl. Inst. of Advanced Industrial Science and Technology, AIST, Japan.* The carrier envelope phase of a polarization-maintaining fiber frequency comb laser is stabilized for long periods of time using near orthogonal fast and slow controls of carrier envelope phase and repetition rate.

OFJ3 • 11:15 a.m.
Mode-Locked Fiber Lasers Using Vertically Aligned Carbon Nanotubes Directly Synthesized onto Substrates, *Yusuke Inoue[1], Shinji Yamashita[2], Shigeo Maruyama[3], Youichi Murakami[3], Hiroshi Yaguchi[4], Tomoharu Kotake[4], Sze Y. Set[4]; [1]Dept. of Frontier Informatics, Univ. of Tokyo, Japan, [2]Dept. of Electronic Engineering, Univ. of Tokyo, Japan, [3]Dept. of Mechanical Engineering, Univ. of Tokyo, Japan, [4]Alnair Labs Corp., Japan.* We demonstrate novel passively mode-locked fiber lasers using vertically aligned carbon nanotubes synthesized using the low-temperature alcohol catalytic CVD method. We found that the laser can be mode locked at wide range of slant angle.

Ballroom C

OFK • Resonator and Sagnac-Based Devices—Continued

OFK2 • 10:45 a.m.
Microcoil Photonic Resonator and Waveguide, *Misha Sumetsky; OFS Labs, USA.* The principal electromagnetic properties of the recently invented optical fiber microcoil resonator, which is suggested as a basic functional element for the future microfiber-based photonics, are investigated theoretically.

OFK3 • 11:00 a.m. Invited
Nonlinear and Active Optical III-V Semiconductor Micro-Resonators, *Rohit Grover[1], Kuldeep Amarnath[2], Tarek A. Ibrahim[1], Ping Tong-Ho[2]; [1]Intel Corp., USA, [2]Lab for Physical Sciences, USA.* We review our work on GaAs-AlGaAs and GaInAsP-InP optical micro-ring resonators. These devices are promising and versatile building blocks for future all-optical signal processing and photonic logic circuits, which will enable large-scale monolithic integration for optics.

Ballroom D

OFL • Novel Devices—Continued

OFL2 • 11:00 a.m. Invited
Chromatic Dispersion of Narrow Band Thin Film Filters, *R. M. Fortenberry, Mike Scobey, D. J. Derickson, L. F. Stokes, P. C. Egerton; Bookham Technology, USA.* This paper discusses the chromatic dispersion effects of thin film filters used in telecommunications systems. ITU channel, banded architecture, and low dispersion filter results are presented. Design techniques to improve and manage chromatic dispersion in practical network implementations are discussed.

Notes

Ballroom E

OFM • Detectors and Receivers—Continued

OFM2 • 10:45 a.m.
High-Responsivity, High-Speed, and High-Power Partially Depleted Absorber Waveguide Photodiodes with Relaxed Coupling Tolerances, *Stephane Demiguel[1], Xiaowei Li[1], Ning Li[1], Hao Chen[1], Joe C. Campbell[1], Jian Wei[2], Alex Anselm[2]; [1]Univ. of Texas at Austin, USA, [2]Applied Optoelectronics, USA.* We reported a partially depleted absorber evanescently-coupled waveguide photodiode that achieves 17 mA saturation current, 0.81 A/W responsivity, >50 GHz bandwidth and ±2.0 μm (±1.3 μm) horizontal (vertical) -1 dB coupling tolerances.

OFM3 • 11:00 a.m. Invited
40-Gbps Waveguide Avalanche Photodiodes, *Toshitaka Torikai, Takeshi Nakata, Tomoaki Kato, Kikuo Makita; Japan Aviation Electronics Ltd., Japan.* Thin multiplication waveguide avalanche photodiodes have been developed for use in 40-Gbps receivers. High responsivity of 0.73-0.88 A/W, wide bandwidth of 30-35 GHz, and gain-bandwidth product of 140-180 GHz have realized the receiver sensitivity of -19 dBm at 40 Gbps.

Room 303A-B

OFN • 40 Gb/s Transmission—Continued

OFN2 • 10:45 a.m.
Performance Comparison of Modulation Formats for 40 Gbit/s DWDM Transmission Systems, *Masahiro Daikoku; KDDI R&D Labs Inc., Japan.* The performance of various modulation formats, namely OOK, DPSK and DQPSK with and without RZ carving, were experimentally compared to clarify the optimum modulation formats for 40 Gbit/s DWDM transmission systems with 50 GHz channel spacing.

OFN3 • 11:00 a.m.
Impairments of Bit-to-Bit Alternate-Polarization on Nonlinear Threshold, CD and DGD Tolerance of 43 Gb/s ASK and DPSK Formats, *Axel Klekamp, Roman Dischler, Wilfried Idler; Alcatel R&I, Germany.* Applying bit-to-bit alternate-polarization modulation at 43Gb/s ASK/DPSK formats, we found experimentally nonlinear threshold benefit up to 4dB at RZ and 2dB at NRZ, reduction of DGD tolerance up to 3ps at RZ formats and of dispersion-tolerance of 20% at DPSK-NRZ.

OFN4 • 11:15 a.m.
Experimental Study of Photocurrent Imbalance in a 42.7-Gb/s DPSK Receiver under Strong Optical Filtering, *Anjali Agarwal, S. Chandrasekhar, Peter Winzer; Lucent Technologies, USA.* We study the effect of optical filter concatenation on a 42.7-Gb/s, 67% duty cycle RZ-DPSK signal and show that system performance can be greatly improved when the balanced DPSK receiver is intentionally amplitude imbalanced.

Room 303C-D

OFO • Electrical Processing—Continued

OFO2 • 11:00 a.m.
Correlation Sensitive Viterbi Equalization of 10 Gb/s Signals in Bandwidth Limited Receivers, *Fred Buchali, Henning Bülow; Alcatel SEL AG, Germany.* Viterbi equalization in bandwidth limited receivers requires correlation sensitive algorithms more than increased state algorithms. The application of both enables equalization at 10 Gb/s with 1 dB add on penalty, if a 2.5 Gb/s receiver is applied.

OFO3 • 11:15 a.m.
A 10 Gb/s Adaptive Equalizer with Integrated Clock and Data Recovery for Optical Transmission Systems, *Douglas S. McPherson, Hai Tran, Mark Rollins, Dave Dobson, Kenny Jiang, Stan Wolski, Petre Popescu; Quake Technologies Inc., Canada.* A self-adaptive electronic equalizer with integrated clock and data recovery is presented. The capacity of the device to mitigate signal impairments at 10 Gb/s is demonstrated using three electrical channels having up to 3.5 unit intervals of intersymbol interference.

Room 304A-B

OFP • Emerging Applications and Technologies—Continued

OFP2 • 11:00 a.m.
First Experimental Demonstration of IP-Client-to-IP-Client Video Streaming Application over an All-Optical Label-Switching Network with Edge Routers, *Junqiang Hu, Zhong Pan, Zuqing Zhu, Haijun Yang, Tinoosh Mohsenin, Venkatesh Akella, S.J.Ben Yoo; Univ. of California at Davis, USA.* We demonstrate, for the first time to our knowledge, successful transmission and switching of video streaming traffic from an IP-client to an IP-client on an optical label-switching network testbed.

OFP3 • 11:15 a.m.
Generation and Propagation of a 1550 nm 10 Gbit/s Optical Orthogonal Frequency Division Multiplexed Signal over 1000m of Multimode Fibre Using a Directly Modulated DFB, *Nigel Jolley, Huai Kee, Robin Rickard, Jianming Tang; Nortel Networks, UK.* OFDM is a spectrally efficient, robust and flexible modulation format. We have theoretically and practically investigated Optical OFDM at the highest ever data rate of 10 Gbit/s and successfully transmitted a signal over 1000m of multimode fibre.

Notes

Ballroom A

OFI • PONs—Continued

OFI5 • 11:30 a.m.
Demonstration and Performance Analysis of Gigabit-Ethernet PON System Accommodating 64 ONUs, *Keiji Tanaka[1], Kazuho Ohara[1], Noriyuki Miyazaki[1], Hirotaka Shigenaga[2], Masato Kuwazuru[2], Noboru Edagawa[1]; [1]KDDI R&D Labs Inc., Japan, [2]KDDI Corp., Japan.* We have demonstrated a two-wavelength Gigabit-Ethernet PON system accommodating 64 ONUs, and have evaluated its performance to clarify the feasibility of commercial applications. We have confirmed that high-quality triple play services can be achieved with high throughput.

OFI6 • 11:45 a.m.
Efficient Dynamic Bandwidth Allocation Based on Upstream Broadcast in Ethernet Passive Optical Networks, *Elaine Wong[1,2], Chang-Joon Chae[2,3]; [1]Australian Photonics CRC, Australia, [2]NICTA Victoria Labs, Australia, [3]ARC Special Res. Ctr. for Ultra Broadband Networks, Australia.* We propose a novel dynamic bandwidth allocation scheme that exploits a physical layer architecture to facilitate upstream broadcast in an EPON. The network meets stringent QoS requirements, achieves high channel utilization, and optimizes downstream capacity.

Ballroom B

OFJ • Pulsed Lasers—Continued

OFJ4 • 11:30 a.m. Invited
Fiber Lasers for Lidar, *John E. Koroshetz; Northrop Grumman Laser Systems, USA.* Advances in fiber laser technology can be used to further the capabilities of lidar remote sensing systems. The paper provides an overview of lidar requirements, where current fiber technology can play a role, and advances needed for future systems.

Ballroom C

OFK • Resonator and Sagnac-Based Devices—Continued

OFK4 • 11:30 a.m.
Coupled-Resonator-Induced Transparency in a Fiber System, *David D. Smith[1], Nick Lepeshkin[2], Aaron Schweinsberg[2], Robert W. Boyd[2], Deborah J. Jackson[3]; [1]Science Directorate, NASA Marshall Space Flight Ctr., USA, [2]Inst. of Optics, Univ. of Rochester, USA, [3]Quantum Computing Technologies Group, JPL, USA.* We observe splitting of the modes in a coupled-fiber-ring resonator system. This splitting leads to a greatly enhanced transmission (cancellation of absorption) on resonance. We show the analogies between this effect and classical electromagnetically-induced transparency.

OFK5 • 11:45 a.m.
Fully-Integrated Planar-Waveguide Resonator Optics Based on Holographic Bragg Reflectors, *Christoph M. Greiner, Dmitri Iazikov, Thomas W. Mossberg; LightSmyth Technologies, USA.* We demonstrate an integrated concentric Fabry-Perot resonator based on holographic Bragg reflectors. The cavity, fabricated in a low-loss silica-on-silicon slab waveguide using high-fidelity deep ultra violet photolitho-graphic fabrication, exhibits a reflectivity-limited Q-factor of approximately 105.

Ballroom D

OFL • Novel Devices—Continued

OFL3 • 11:30 a.m.
Advanced Thin-Film Filter for Passive Optical Networks, *Noboru Uehara, Ryosuke Okuda, Toshitaka Shidata, Ryohei Otowa; Santec Corp., Japan.* We describe an advanced high isolation thin-film filter for passive optical networks. Transmission and reflection isolations of 44 dB and 52 dB are achieved at 1490 nm band and 1555 nm band, respectively.

OFL4 • 11:45 a.m.
III-Nitride-Based Planar Lightwave Circuits for Optical Communications, *Rongqing Hui[1], Yueting Wan[1], Jing Li[2], Sixuan Jin[2], Jingyu Lin[2], Hongxing Jiang[2]; [1]Dept. EECS, Univ. of Kansas, USA, [2]Dept. of Physics, Kansas State Univ., USA.* Planar lightwave circuits based on III-nitride wide-bandgap semiconductors is proposed and demonstrated for the first time. The feasibility of developing III-nitride-based photonic integrated circuits for applications in 1550nm fiber-optic communications is discussed.

Notes

Ballroom E

OFM • Detectors and Receivers—Continued

OFM4 • 11:30 a.m.
A Low-Dark-Current InGaAs Photodetector Made on Metamorphic InGaP Buffered GaAs Substrate, *Chi-Kuan Lin[1], Hao-Chung Kuo[1], Gong-Ru Lin[1], M. Feng[2]; [1]Dept. of Photonics and Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan Republic of China, [2]Dept. of Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA.* A novel top-illuminated In0.53Ga0.47As p-i-n photodiode grown on linearly graded metamorphic InxGa1-xP (0.51<x<1) buffered GaAs substrate is demonstrated with dark current, responsivity, noise-equipment power, and bandwidth of 13 pA, 0.77 A/W, 6.9x10-11 W/Hz0.5, and 7.5 GHz, respectively.

OFM5 • 11:45 a.m.
-29dBm Sensitivity, InAlAs APD-Based Receiver for 10Gb/s Long-Haul (LR-2) Applications, *J.A. Valdmanis, B.F. Levine, R.N. Sacks, M. Jazwiecki, J.H. Meier; Picometrix, USA.* We present an APD-based receiver for 10Gb/s applications that achieves record-setting sensitivity of -29 dBm, and is based on a new, planar, InAlAs APD that is Telcordia qualified.

Room 303A-B

OFN • 40 Gb/s Transmission—Continued

OFN5 • 11:30 a.m. Invited
40 Gb/s-Based WDM 4,300 km Straight Line Transmission and Comparison of Re-Circulating Loop Line, *Katsuyuki Mino; NEC Corp., Japan.* Direct performance comparison between the straight line and re-circulating fiber-loop configurations was described in terms of mean Q and Q variance through 42.8 Gb/s x 32 WDM transmission over 4,300 km.

Room 303C-D

OFO • Electrical Processing—Continued

OFO4 • 11:30 a.m.
Electronic Dispersion Compensation for 10 Gigabit Communication Links over FDDI Legacy Multimode Fiber, *Jan P. Peeters Weem, Pete E. Kirkpatrick, Jean-Marc Verdiell; Intel Corp., USA.* In this paper we demonstrate measured results from two different EDC architectures, a Feed Forward Equalizer (FFE) and a Decision Feedback Equalizer (DFE). These are used to compensate for ISI caused by modal dispersion in highly band-limited multi-mode fiber links.

OFO5 • 11:45 a.m.
Statistical Analysis of Electrical Equalization of Differential Mode Delay in MMF Links for 10-Gigabit Ethernet, *Chunmin Xia, Werner Rosenkranz; Chair for Communications, Univ. of Kiel, Germany.* Through statistical analysis of a large number of worst-case multimode fiber channels, we demonstrate that using electrical equalization, the 300m-transmission reach at 10Gb/s can be guaranteed for installed multimode fiber under any launch condition.

Room 304A-B

OFP • Emerging Applications and Technologies—Continued

OFP4 • 11:30 a.m. Invited
Recent Progress of Digital Cinema over Optical Networks, *Tetsuro Fujii; NTT Network Innovation Labs, Japan.* A new Super High Definition digital cinema distribution system with the resolution of 8-million (4K x 2K) pixel is developed. This system opens the door to the next generation of cinema-class digital content distribution over optical networks.

Notes

Ballroom A

OFI • PONs—Continued

OFI7 • 12:00 p.m.
A Fast-Response Dynamic Bandwidth Allocation Scheme for an Ethernet PON, *Wei Zou, Yan Zhao, Shan Jin, Luoning Gui; ASB, China.* This paper proposes a novel dynamic bandwidth allocation scheme with fast response, which significantly reduces the processing-speed requirement of optical line terminal. Moreover, the scheme can provide high bandwidth efficiency while ensuring a bandwidth guarantee.

OFI8 • 12:15 p.m.
Use of Downstream Inverse-RZ Signal for Upstream Data Re-Modulation in a WDM Passive Optical Network, *Guowei Lu, Ning Deng, Chun-Kit Chan, Lian-Kuan Chen; The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China.* We propose and experimentally investigate a novel WDM-PON architecture using inverse-RZ modulated centralized light sources. The finite optical power in each bit of the downstream IRZ signal can greatly facilitate the upstream data re-modulation.

Ballroom B

OFJ • Pulsed Lasers—Continued

OFJ5 • 12:00 p.m.
100-nm Tuning Range, Picosecond Pulse Generation Employing a PM Fiber Loop Filter in a Mode-Locked SOA Ring Laser, *W. W. Tang[1], M. P. Fok[1], C. Shu[2]; [1]Dept. of Electronic Engineering, The Chinese Univ. of Hong Kong, Hong Kong Special Administrative Region of China, [2]Dept. of Electronic Engineering and Ctr. for Advanced Res. in Photonics, Hong Kong Special Administrative Region of China.* Picosecond-pulses with a center-wavelength spanning from 1489nm to 1589nm is generated by a harmonically mode-locked fiber laser that exploits a SOA to provide both optical gain and mode-locking. Optical pulses with a tuning range of 100nm are generated at 4.7GHz.

OFJ6 • 12:15 p.m.
Phase Noise and Supermode Suppression in Harmonic Mode-Locked Erbium-Doped Fiber Laser with a Semiconductor Optical Amplifier Based High-Pass Filter, *Ming-Chung Wu, Yung-Cheng Chang, Gong-Ru Lin; Dept. of Photonics & Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan Republic of China.* The variations and trade-off between the single side band phase noise, supermode noise suppression ratio and pulsewidth of a mode-locked erbium-doped fiber laser with an intra-cavity semiconductor optical amplifier based high-pass filter are discussed.

Ballroom C

OFK • Resonator and Sagnac-Based Devices—Continued

OFK6 • 12:00 p.m.
Compensation of Chromatic Dispersion by Chirp Control in All-Optical Regenerator Based on Asymmetric Sagnac Loop, *Haim Chayet[1], Shalva Ben Ezra[1], Niv Narkiss[1]; Shai Zadok[1], Arieh Sher[1], Erel Granot[1], Ivan Glesk[2], Paul R. Prucnal[2]; [1]Kailight Photonics, Israel, [2]Dept. of Electrical Engineering, Princeton Univ., USA.* We describe the compensation of chromatic dispersion by control of the chirp in an all-optical regenerator, based on SOA in an asymmetric Sagnac loop. We demonstrate the transmission of a 10Gb/s NRZ signal up to 200km

OFK7 • 12:15 p.m.
Novel PDL/PDG Compensator for Transmission Optical Devices Using Sagnac Interferometer, *Chang-Seok Kim, Bernard Choi, John Stuart Nelson, Pedram Zare Dashti, Henry P. Lee; Univ. of California at Irvine, USA.* We describe a novel scheme for complete suppression of polarization-dependent loss/gain (PDL, PDG) for transmission-type optical devices (LPG, SOA) via a $\lambda/2$-shifted all-fiber Sagnac loop interferometer. The results are explained theoretically and demonstrated experimentally.

Ballroom D

OFL • Novel Devices—Continued

OFL5 • 12:00 p.m.
Tuneable All-Fiber® Delay-Line Interferometer for DPSK Demodulation, *François Séguin, François Gonthier; ITF Optical Technologies, Canada.* An All-Fiber® tunable Mach-Zehnder delay line interferometer was developed for DPSK demodulation. Low loss and high isolation are maintained in a compact package by annealing the fibers at high temperature to relieve bending stresses. Reliability data is presented.

OFL6 • 12:15 p.m.
A Monolithic Ultra-Compact InP O-CDMA Encoder with Planarization by HVPE Regrowth, *Jing Cao[1], Ronald G. Broeke[1], Chen Ji[1], Yixue Du[1], Nikolai Chubun[1], Peter Bjeletich[1], S. J. B. Yoo[1], Fredrik Olsson[2], Sebastian Lourdudoss[2], Phillip L. Stephan[3]; [1]Univ. of California at Davis, USA, [2]Royal Inst. of Technology, Sweden, [3]Lawrence Livermore Natl. Lab, USA.* We report a monolithic, ultra-compact optical-CDMA encoder/decoder photonic chip in InP with surface planarization by low-pressure Hydride-Vapor-Phase-Epitaxy regrowth. The chip consists of an AWG pair and eight electro-optic phase shifters and demonstrated excellent encoding operation.

Notes

Ballroom E

OFM • Detectors and Receivers—Continued

OFM6 • 12:00 p.m.
A Burst-Mode Optical Receiver with High Sensitivity Using a PIN-PD for a 1.25 Gbit/s PON System, *Makoto Nakamura, Yuhki Imai, Yohtaro Umeda, Jun Endo, Yuji Akatsu; NTT Photonics Labs, Japan.* A 1.25-Gbit/s burst-mode optical receiver for access networks was developed. We devised TIA and LIM circuits using a PIN-PD instead of an APD, and the receiver exhibits high sensitivity of -30 dBm.

OFM7 • 12:15 p.m.
Wavelength-Tunable Receiver Channel Selection and Filtering Using SG-DBR Laser Injection-Locking, *Leif A. Johansson, Larry A. Coldren; Univ. of California at Santa Barbara, USA.* An injection-locked SGDBR laser is used for wavelength-tunable receiver channel selection and filtering. Successful phase tracking of a 2Gbps DPSK modulated signal at 10 GHz channel spacing was achieved.

Room 303A-B

OFN • 40 Gb/s Transmission—Continued

OFN6 • 12:00 p.m.
Ultra-Long Transmission Performance Evaluation of 43Gbit/s CSRZ-DPSK DWDM Signal Using 4,300km DMF Line, *Toshiharu Ito, Kiyoshi Fukuchi, Katsuyuki Mino, Yoshihisa Inada, Takaaki Ogata; NEC Corp., Japan.* More than 10,000km transmission capability was confirmed with 43Gbit/s CSRZ-DPSK and conventional DMF line. But the polarization dependent effects never guaranteed the complete stability at 4,300km where the Q-factor margin of 5dB was obtained in the short-term evaluation.

Room 303C-D

Room 304A-B

OFP • Emerging Applications and Technologies—Continued

OFP5 • 12:00 p.m.
200x200 Automated Optical Fiber Cross-Connect Equipment Using a Fiber-Handling Robot for Optical Cabling Systems, *Masato Mizukami, Mitsuhiro Makihara, Shuichiro Inagaki, Kunihiko Sasakura; NTT Microsystem Integration Labs, Japan.* An automated optical fiber cross-connect equipment using a fiber-handling robot reduces both operation and equipment costs and enables us to construct reliable optical network for intelligent buildings and optical access network facilities.

OFP6 • 12:15 p.m.
Performance of IP over Optical Networks with Dynamic Bandwidth Allocation, *Joel W. Gannett, George Clapp, Ronald A. Skoog, Ann Von Lehmen; Telcordia Technologies, Inc, USA.* IP over optical network performance can be improved with dynamic bandwidth allocation, depending on the reallocation paradigm and the network topology. Under high connectivity, dynamic bandwidth allocation provides a notable boost to the network's traffic-carrying capacity.

Notes

FIG. 9A

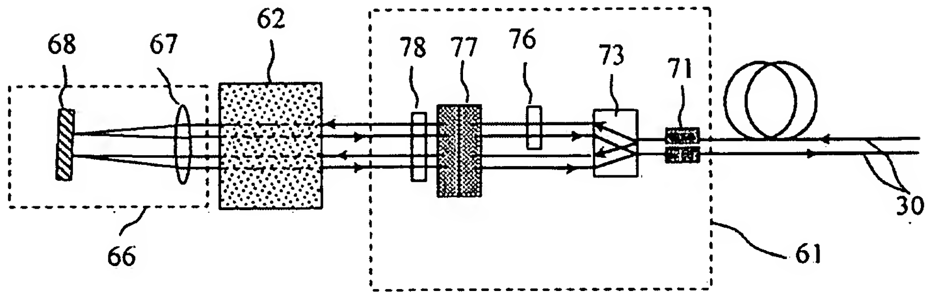

FIG. 9B

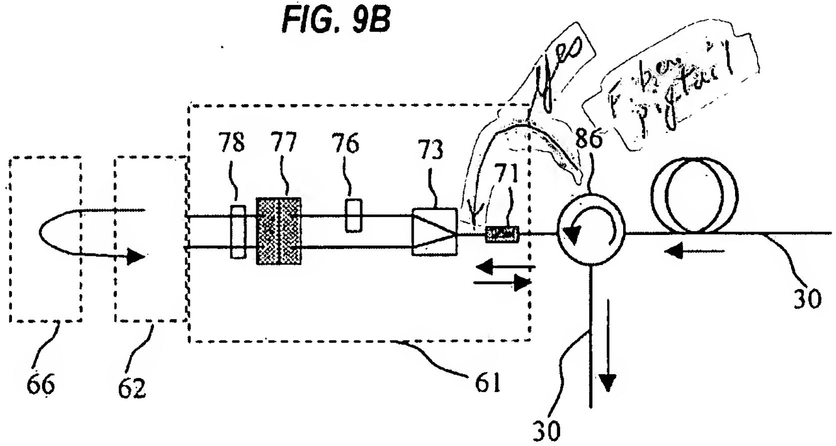

FIG. 10